# Knowledge, opinions and practice of essential infection control measures : a comparative study of nurses in different clinical settings.

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# Knowledge, Opinions and Practice of Essential Infection Control Measures: a comparative study of nurses in different clinical settings

by

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# ABSTRACT

Knowledge, opinions and practice of infection control precautions: a comparison of nurses employed in different clinical settings.

Knowledge, opinions and performance of three key procedures designed to control the spread of infection (hand decontamination, glovewearing and sharps use) were assessed for one hundred and seventy-three qualified nurses. In the absence of suitable existing measurement devices all were developed especially for the study, a process involving the construction and validation of three questionnaires to assess knowledge, a Likert scale and interview to examine opinions concerning infection and a schedule to document behaviour in the clinical situation. Two hours non-participant observation were conducted with each subject. Nursing workload was assessed by documenting the total number of clinical contacts performed. The availability of equipment to help contain infection (e.g. gloves, sharps boxes) was recorded. Comparisons were drawn between nurses employed in three different settings (intensive care, surgical and medical units) and between nurses in two hospitals, one employing an infection control nurse and demonstrating recently updated infection control policies, the other lacking these facilities. Informal fieldnotes were maintained. Data pertaining to ward atmosphere were collected in the second hospital. Multiple methods of data collection were therefore adopted in an attempt to capture complete information.

Contrary to expectation nurses in ITU did not hold more positive opinions regarding the prevention of infection than those on other wards, although they were more likely to consider their patients to be at particular risk. Knowledge for the sample overall was rated poor. Levels were similar for nurses in all three clinical areas but significantly better for those in the second hospital where no infection control nurse was employed. Some aspects of knowledge and opinions were associated with clinical performance. Increasing workload did not reduce the technique of hand decontamination. As in previous studies, hand decontamination was often poorly performed but the use of gloves and sharps was more satisfactory. Performance was closely related to the particular ward or unit where data were collected and influenced by the availability of resources. There was tentative evidence that ward atmosphere might influence clinical performance.

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# INTRODUCTION

## BACKGROUND TO THE STUDY

Hospital acquired infection
(HAI)is defined as infection neither present or incubating before hospital admission (*Scheckler, 1978; Bennet and Brachman, 1979*). Notorious for its economic burden to the health service (*Dixon, 1978, French and Cheng, 1991*), it is known on the basis of epidemiological studies to affect approximately 10% of in-patients (*Meers, Ayliffe, Emmerson et al, 1981*) although this can be effectively reduced through the collaborative efforts of an infection control nurse and microbiologist (*Haley, Culver, White et al, 1985*). Expense to the health service generated by HAI is substantial (*Rubenstein, Green, Nolan et al, 1982*) but inconvenience and distress to patients are seldom taken into account, though considerable (*Davey, Hernanz, Lynch et al, 1991*).

HAI is disseminated predominantly by contact (*Casewell and Phillips, 1978; Reybrouck, 1983*). The most effective means of preventing spread is by a stringent regime of hand decontamination (*Larson, 1988*), either through traditional handwashing (*Larson and Lusk, 1985*) or the use of alcoholic handrubs (*Larson, Eke and Laughton, 1986*). Soap from a wall dispenser or medicated agents may be employed (*Sprunt, Redman and Leidy, 1973; Ayliffe, Babb and Davies, 1988*). Extensive laboratory studies have indicated the superiority of medicated agents in bactericidal terms (*Ayliffe, Babb and Davies, 1990*), but as indicated in an early review by *Steere and Mallison (1975)*, choice may be dictated by costs with expensive agents reserved for recognised high risk areas (e.g. theatres, intensive care).

Despite the relative straightforwardness of hand decontamination as a preventative measure, compliance is poor (*Wenzel and Pfaller, 1991; Zimacoff, Kjelsberg, Larsen et al, 1992*). Numerous reasons have been suggested including poor facilities, especially insufficient sinks (*Broughall, Jackman and Marshman, 1984*), dislike of hand decontamination agents which can be sufficiently harsh to damage skin (*Larson and Killien, 1982; Ojajarvi, 1991*), lack of knowledge (*Sedgwick, 1984*) and poor motivation (*Bartzokas and Slade, 1991*). The final suggestion may be nearest the truth: supplying handrub with emollients does not result in sustained improvement (*Graham, 1990*), educational campaigns appear to have only short-term effectiveness (*Mayer, Dubert, Miller et al, 1986; Williams and Buckles, 1988; Conly, Hill, Ross et al, 1989*) and providing more sinks has increased compliance in some studies (*Kaplan and McGucklin, 1986*) but not others (*Preston, Larson and Stamm, 1981*). According to *Worsley (1988)* infection control nurses play a key role developing infection control protocols but *Cadwallader (1989)*, disappointed at lack of enthusiasm displayed by clinical staff towards a newly implemented infection control policy, argues that their expertise remains of limited value unless supported by nurses directly responsible for patient care. However, there is evidence that peer pressure can increase handwashing frequency (*Larson, 1983*) and that clinical nurses are interested and deeply concerned about issues related to infection control (*Matthews, 1991; Gill and Slater, 1991*).

The use of gloves to reduce HAI has been recommended when wards are busy (*Lowbury, Thom, Lilley et al, 1970*), during outbreaks (*Noone, Pit, Bedder et al, 1983*) and after tasks when hands are likely to become heavily contaminated (*Kjolen and Andersen, 1992*).

Glove-wearing has contributed to the containment of outbreaks although their contribution is inseparable from that of increased handwashing (*Curie, Speller, Simpson et al, 1978*). Thus gloves may be considered an important additional precaution against HAI.

Health professionals may also develop infections, but fewer definitions of HAI applied to staff are available. According to *Hyams, Strewe and Heitzer (1984)* any infection known to have developed at work in hospital should be regarded as nosocomial. These authors, calculating the cost of nurses' enforced sick leave through nosocomial Varicella infection concluded that disruption to the hospital service had been expensive, but failed to consider inconvenience to the nurses.

Other writers have focused on parenteral virus infections - hepatitis B (HBV) and the human immunodeficiency virus (HIV) (*Geddes, 1986,; Goodacre, 1987*). Risks are thought to increase with length of time in service, particularly when invasive procedures are frequently performed (*Denes, Smith, Maynard et al, 1978; Collins and Kennedy, 1987*), though the very inexperienced are also at risk, especially nurses (*Jagger, Hunt and Pearson, 1990; Yassi and McGill, 1991*). Some authors question the value of gloves (*Goldmann, 1991*), and there are reports of inappropriate use (*Stringer, Smith, Scharf et al, 1991; Denton, 1991*). However, wearing gloves when contact with blood and body fluids is anticipated remains an established precaution against parenteral infections (*Gurevich, 1988; Linden, 1991*), although it may be overlooked, especially in emergency situations (*Kelen, Di Giovanna, Bisson et al, 1989*). Similarly, the handling and disposal of sharp instruments (needles, scalpels) is often careless (*Becker, Janz, Band et al, 1990*).

As the literature in this area is not conclusive and fails to address crucial issues such as the influence of nurses' professional qualification, experience and the possible effect of clinical setting on performance of hand decontamination, glove and sharps use, it was decided to undertake a descriptive study to examine these variables precisely.

**Aims**

The aims of the study generated from the literature and omissions within it were:- to investigate nurses' clinical performance of three key aspects of infection control (hand decontamination, glove and sharps use); and to determine the influence of knowledge, opinions of HAI, availability of equipment and levels of ward activity on behaviour. The effects of sociodemographic variables (professional nursing qualification, holding a relevant postbasic certificate, having three or more years experience in the clinical specialty and number of years qualified) were also considered.

It was intended that the main study sample would consist of one hundred and eighty nurses, half employed in a hospital with an infection control nurse and recently updated infection control policies (Hospital A) and the remainder employed in a comparable institution lacking these facilities (Hospital B). In order to compare the possible effect of clinical setting, data were collected from intensive care (ITU), surgical and medical units. It was intended to recruit one third of the sample from each area as explained in Chapter Five.

The report assumes the following structure:- a literature review (four chapters); method; presentation of findings; and discussion of results with recommendations for future research.

The literature review is concerned with nosocomial infection among patients and hospital employees. Chapter One is concerned with the epidemiology of HAI among patients and the role of national and local hospital policies for prevention. The function of the infection control nurse is discussed. Chapter Two considers mechanisms of bacterial dissemination, concluding that in hospital spread is chiefly by direct contact via hands. Chapter Three builds on studies reviewed earlier by examining ways in which HAI can be reduced through hand decontamination and glove use, debating why compliance with these apparently straightforward precautions remains poor. Chapter Four is concerned with nosocomial parenteral infection.

The broad aims of the study generated through the material reviewed and omissions within the literature were:-

(1) To investigate nurses' knowledge, opinions and performance of three essential aspects of infection control:- hand decontamination, glove and sharps use.

(2) To observe how knowledge and opinions of the above aspects of infection control are translated into clinical practice.

(3) To compare and contrast knowledge, opinions and clinical practice between:-

    i. Nurses employed in different clinical settings: intensive care, surgical and medical units.

    ii. Experienced and less experienced nurses.

    iii. Nurses employed in hospitals with and without an infection control nurse.

(4) To examine how levels of ward activity influence nurses' execution of infection control procedures.

More detailed objectives and hypotheses are presented in Chapter Five.

# CHAPTER ONE

# THE EPIDEMIOLOGY OF HOSPITAL ACQUIRED INFECTION AND THE ROLE OF NATIONAL AND LOCAL POLICY IN PREVENTION

The purpose of this chapter is to demonstrate that HAI is a significant problem among in-patients which has been tackled by the development of policies at local and national level. Review of the literature indicates patients most at risk, although epidemiological approaches taken to establish this information vary considerably, affecting results and conclusions drawn from them (*Freeman and McGowan, 1978*). Before attention can be given to those studies which demonstrate the method of dissemination of infection in hospital it is therefore necessary to critically discuss epidemiological methods. In the second part of the chapter the role of the infection control nurse and policies for prevention are discussed.

## The Epidemiology of Hospital Acquired Infection

### Introduction

International studies demonstrate that HAI occurs most frequently among surgical patients especially those in intensive care units (ITU) (see *Daschner, Frey, Wolff et al, 1982; Donowitz, Wenzel and Hoyt, 1982*).

The urinary tract is most often affected, particularly among catheterised patients, followed by wounds and the lower respiratory tract (*Scheckler, 1978; Meers et al, 1981*), although septicaemia is also considered a major hazard (*Wenzel, 1988*).

A retrospective survey of sixteen literature reports between 1933 and 1973 revealed that hospital stay was prolonged between 1.3 and 26.3 days as a result of HAI (*Brachman, Dan, Haley et al, 1980*). HAI contributes directly to morbidity and mortality (*Gross, Neu, Answakopee et al, 1980*), especially among the most debilitated patients (*Britt, Scheiupner and Matsumiya, 1978; Peacock, Marsik and Wenzel, 1980; Scott-Evans, Burke, Classen et al, 1992*), who are most likely to be immunocompromised (*Zimmerli, 1985*). Invasive devices and procedures greatly increase risks of HAI (*Rose and Babcock, 1975; Wenzel, Ostermann and Hunting, 1976; Stamm, 1978*). Most nosocomial infections are bacterial, but outbreaks of viral infections (*Hall, 1981*) and fungal infections (*Lee, Burnie, Matthews et al, 1991*) have been recorded.

Lack of consensus between studies and findings may reflect genuine changes over time. Early writers document streptococci as important causative agents superseded by staphylococci and coliforms (see *Goodall, 1952*). Over the years antibiotic resistance has become an increasing problem (*McGowan, 1991*). However, new typing methods and other sophisticated laboratory techniques have drawn attention to pathogenic behaviour in bacteria previously regarded as harmless (*Hussain, Kuhn, Lannigan et al, 1988; Lee et al, 1991*). In other cases apparent disagreement between rates of HAI may to a considerable extent rest on different methodological approaches. Direct comparisons of results achieved by different methods are neither valid or meaningful (*Freeman and McGowan 1978*). Results are affected by patient population, the way samples are drawn, criteria employed to define infection and means of data collection.

Duration of follow-up is influential. Patients have been most thoroughly studied while still in hospital, but there is evidence that infection, particularly in wounds, may not become apparent until after discharge (*Lynch, Davey, Malek et al, 1992*). Attempts to document HAI after return to the community have been conducted in some centres (*Frey, Briggs and Broadhead, 1990; Molyneux, 1991*). Extending the period of data collection increases opportunity to record infection. Duration of hospital stay and consideration of possible risk factors on observed rates of HAI are included in some, but not all studies. Each of these factors will be explored below.

**Population**

Populations have varied considerably. Some studies have been limited to a particular hospital or unit (*Schaberg, Haley, Highsmith et al, 1980*) or to a geographical area (*Ayliffe, Brightwell, Collins et al, 1977*), although comprehensive, large scale investigations have been conducted in both the U.K. (*Meers et al, 1981*) and the USA (*Haley, Culver, White et al, 1982*). Some authors have concentrated on a particular clinical area or patient group shown through previous research to be at high risk (*Donowitz et al, 1982*), examined infection rates associated with a particular anatomical site (*Leu, Kaiser, Mori et al, 1989*), or medical device or procedure believed to place patients at risk of HAI (*Nystrom, Larson, Dankert et al, 1983*). Studies have also been concerned with infections caused by particular types of organism, chiefly staphylococci (see *Peacock et al, 1980; Thompson, Cabezudo and Wenzel, 1982*) or Gram negative rods (see *Sanders, Luby, Johanson et al, 1970*). This multiplicity of approaches has undoubtedly affected findings and created difficulties when authors have attempted to compare them.

## Sampling

Sampling has also been approached in different ways. The frequency of HAI in a study by *Daschner et al (1982)* varied between 3% and 27%, not surprisingly, as the Swiss and German patients in their multicentre samples had differing lengths of hospital stay. Paediatric intensive care patients were included, while many other research teams specifically exclude children and sometimes other patient groups from analysis: for example, the study by *Meers et al (1981)*.

Variation in rates of bacteraemia among surgical patients with intravenous devices led *Nystrom et al (1983)* to conduct an incidence study among 10,616 patients in forty-two hospitals throughout eight countries. The incidence of device-related thrombophlebitis was 10.3%, but there was considerable variation: 7.8% to 28.4%, probably reflecting differing clinical practice, though the authors could not always determine the cause. There was no demonstrable correlation between numbers of intravenous catheter days per site for patients with peripheral lines and hospital-acquired bacteraemia, probably because of the trend to leave intravenous lines in situ for as short a time as possible in all centres visited.

Opportunity for the introduction of bias is apparent in other large scale, well-planned studies. In the U.K. National Prevalence Survey (*Meers et al, 1981*), the authors' comprehensive critique points out that hospitals where the infection control team was particularly vigilant may have been over-represented among the forty institutions visited, as the most conscientious or those believing they had least to hide may have tended to participate. The nature of the institution is almost certainly influential in determining infection rates.

Acute and university hospitals have been studied more often than those catering specifically for long term patients (*Muder, Brennan, Vickers et al, 1991*). Where continuing care institutions have been examined results may have been artificially depressed because facilities for microbiological testing were limited: some hospitals specifically exclude infectious patients (*Pearson, Checko, Hierholzer et al, 1990*). Some differences in infection rates between centres may, however, be genuine, reflecting the different conditions under which patients receive care in university and other hospitals. Fewer invasive procedures are performed in the latter, reducing risks of HAI (*Setia and Gross, 1977*).

Circumstances surrounding a particular epidemiological enquiry also influence results. Traditionally many of the smaller scale investigations have reported the identification and control of an outbreak but, as *Rosello, Olona, Campins et al (1992)* point out, the manner in which the problem is identified will influence action taken and findings: clinical microbiologists may vary in what they perceive as problematic. *Stamm, Weinstein and Dixon (1981)* consider these reports valuable, believing they help define sources of infection and modes of spread, offering possibilities for future prevention. However, outbreaks account for only a small proportion of nosocomial infections which occur through an extraordinary combination of circumstances, not generalisable to other situations. For example, *Bentham (1979)* describes an outbreak of klebsiella in which transfer to patients probably occurred via hands contaminated when nurses removed overshoes having trodden in effluent from a leaking bedpan macerator.

A carefully controlled trial by *Danforth, Nicolle, Hume et al (1987)* could demonstrate no difference in rates of HAI whether floors were cleaned with detergent or disinfectant, supporting the much earlier conclusion of *Ayliffe, Collins and Lowbury (1966)* that although hospital floors are liberally contaminated with potential pathogens, disinfection is costly and unnecessary. *Bentham (1979)* may have identified a unique train of events, which with satisfactory routine maintenance of equipment should not recur. Similarly, *Whitby, Blair and Rampling (1972)* traced an outbreak of Serratia marcescens to contaminated shaving brushes, but in a second outbreak the same fomites were no longer implicated, though still in use. More striking still is the discovery by *Martone, Osterman, Fisher et al (1981)* that the source of Pseudomonas cepacia in an outbreak involving fifty-six patients proved to be contaminated aqueous cocaine, prepared several hours before bronchoscopy.

As well as being triggered by unusual circumstances, the action taken may subsequently alter the course of an epidemic, as many patients will receive antibiotics which they would not otherwise have been given. This may increase the carriage rate of antibiotic resistant plasmids, altering usual environmental reservoirs.

Studies of microbiol behaviour under endemic circumstances are possibly more useful because they enhance understanding of common reservoirs and modes of transmission (*Haverkorn and Michel, 1979; Olson, Weinstein, Nathan et al, 1984*).

Examining pseudomonal behaviour under non-epidemic circumstances *Moody, Young and Kenton (1972)* demonstrated that biotypes operating as resident rather than temporary flora were more likely to contribute to clinical infection, while more recently *Musa, Desai and Casewell (1990)* have found that Acinetobacter, a Gram negative opportunist, may tolerate drying and dissemination in dust.

**Definitions**

Definitions of infection are stated explicitly in publications of large, well-organised studies of HAI such as the National Prevalence Survey (*Meers et al, 1981*) and the National Nosocomial Infection Study (NNIS) (*Haley et al, 1985*) but not necessarily all. This may be through shortage of space in journal accounts, not because authors omitted to define criteria precisely. *Muder et al (1991)*, reporting the incidence of methicillin resistant Staphylococcus aureus (MRSA) in a single institution define their criteria for infection, temporary and permanent colonisation clearly, as do *Ryan, Abel and Abbott (1974)* documenting sepsis associated with parenteral feeding lines, but *Daschner et al (1982)* define different types of infection affecting critical care patients in vague terms.

**Method of Data Collection and Presentation of Findings**

Method of data collection may influence sample, therefore determining material entering a final report. Even in comprehensive studies authors comment on the problem of "missing" data (see *Stamm 1978; Haley et al, 1985*). In future this may be overcome through greater accessibility of computerised records (*Gransden, 1991*).

Where data have been collected retrospectively over long periods of time (retrospective chart analysis) there seems greater scope for inaccuracy and omission (see *Kreger, Craven and Carling, 1980*) than in prospective studies where direct examination of patients by the research team trained to use the same criteria for identifying and recording infection in addition to laboratory reports is possible. This was one of the greatest strengths of the National Prevalence Survey (*Meers et al, 1981*). The sheer scope and high level of organisation of the Study of Efficacy of Nosocomial Infection (SENIC) project appears to have overcome these difficulties (*Haley, Schaberg, McClish et al, 1980*) (see page47).

Several epidemiological measures of the occurrence of nosocomial infection appear in the literature: prevalence, incidence, 'attack rate" and number of infections per hundred discharged patients (*Freeman and McGowan, 1978*). Confusion has been generated when authors have used these terms interchangeably within the same report (*Friedman, 1976*). Sometimes the terms are used erroneously. "Prevalence studies" described by *French and Cheng (1991)* are case control incidence studies and will be discussed as an example of this approach (see page43). Confusion arises when authors conduct both prevalence and incidence studies on the same population (*Finland and McGowan, 1976*). The following discussion will define epidemiological terms and highlight the advantages and disadvantages of different approaches specifically in relation to studies of HAI.

**Prevalence Studies**

Prevalence is the proportion of existing cases of a disease in a population (see *Waters and Cliff, 1983; Farmer and Miller, 1983*). Most prevalence surveys critiqued by *Freeman and McGowan (1978)* in their review of epidemiological methodology were point prevalence studies in which prevalence was defined as the total number of patients screened at one time identified with active HAI. The National Prevalence Survey in the U.K. (*Meers et al, 1981*) falls into this category.

Prevalence studies are valuable because they give a "snapshot" view of the extent of a particular problem in a particular place at a given time, but provide little explanation of possible risk factors. There is no means of knowing whether the situation was atypical at the time the study was undertaken. For example *Na'was and Fakhoury (1991)* examined the prevalence of nasal MRSA carriage among staff in four hospitals, but apart from accurately documenting rates of carriage, can make little comment on their significance other than comparing them with one another and the results of similar studies. It was impossible to deduce whether short or long-term carriage was occurring, although this information might have been more valuable when planning the care of susceptible patients.

A further disadvantage of prevalence studies is that they may under-estimate the extent of a disease as each affected individual is counted only once; those previously infected who have died or successfully completed antibiotic treatment at the time of the survey are excluded.

Nevertheless, prevalence studies can be of value if they draw attention to the threat of HAI, especially if they initiate more detailed investigations (*Lilienfield, 1976*). There are indications in the literature that this has occurred (see *Hussain et al, 1988*). They may also be undertaken to document the use of equipment or procedures thought to be associated with risks of HAI (*Mulhall, 1990*). This approach was undertaken by *Dumas, Warner and Dalton (1971)*, who examined maintenance of intravenous volume control sets. There was evidence of poor management contributing to septicaemia. This prompted later infection control experts to develop strict protocols for the care of intravenous lines, reducing sepsis (*Shinozaki, Deane and Mazuzan et al, 1983*). In contrast, *Mulhall, Chapman and Crow (1988)* demonstrated that more than 50% catheterised patients in a random sample developed bacteriuria. The authors acknowledge the limitations of this prevalence study which prevented the development of clear guidelines for clinical practice.

**Incidence Studies**

*Waters and Cliff (1983)* differentiate between prevalence (a state) and incidence (an event), agreeing with *Farmer and Miller (1983)* that incidence is the number of new cases of a disease emerging in a population over a pre-determined period of time. Specifically in relation to HAI, *Friedman (1976)* defines incidence as that fraction of the population at risk of acquiring new nosocomial infections per unit of time exposed. Inevitably the unit of time employed in all studies taking this approach is the hospital day.

In general two problems are associated with the conduct of incidence studies:- length of time necessary to follow up a population before new cases appear and the impracticality of waiting for rare conditions to manifest. These do not present major difficulties with HAI; nosocomial infections are commonplace and, with the exception of parenteral viruses (HBV, HIV), incubation is usually short. Difficulties centre around calculating the strict incidence of HAI directly resulting from a particular admission, especially when individuals are transferred from one centre to another: it is necessary to exclude patients whose infections originated during previous hospital stay by calculating the "attack rate" according to the formula:-

$$\text{\% attack rate} = \frac{\text{No. of individuals exposed to risk within the known range of the incubation period}}{\text{Total no. individuals exposed to the primary source}} \times \frac{100}{1}$$

*(after Freeman and McGowan 1978)*

"Attack rate" of HAI can be regarded as that proportion of patients developing one or more new infections during a particular hospital stay and may be interpreted as the average probability of becoming infected during that admission. This has been used by some authors (see *Wenzel et al 1976*), while others have calculated number of new infections per hundred discharges (*Cruse and Foord, 1973*), leading to confusion when attempting to compare rates.

Despite these drawbacks incidence studies are more valuable than prevalence surveys because they provide information about risk factors. Thus they are more often employed in conjunction with HAI. Several different types are described in the literature.

**Descriptive Incidence Studies**

The aim of a descriptive incidence study is to document the amount and distribution of a disease in a population or sample of it, and to provide information about the type of individual most likely to become affected, suggesting risk factors. It is not possible to prove cause and effect.

Cross-sectional studies are those designed so that all individuals are investigated over one period of time, generally all at the same time. The study by *Ayliffe et al (1977)* investigating possible relationship of age, gender, length of hospital stay and antibiotic therapy on nasal carriage of tetracycline resistant Staphylococcus aureus and post-operative wound infection in thirty-eight hospitals throughout the Midlands is an example of this approach. Among the strengths of the study are its comprehensiveness with a large sample, examination of patients at the bedside by a specially trained survey team (allowing direct inspection of wounds rather than reliance on reports from hospital staff) and clear definitions of infections as "severe", "moderate" or "mild" in accordance with agreed physical signs. A considerable amount of clinically relevant information was generated: infection rates were lowest among young adults (20-40 years) and significantly more common among males than females. Nasal carriage employed as an index of nosocomially-acquired infection was most widespread among geriatric patients and less seldom encountered on gynaecology wards. Older patients who had been in hospital longer were most likely to be carriers, especially if they had received antibiotics. Descriptive incidence studies appear frequently throughout the literature concerned with HAI (see *Setia and Gross, 1977; Garibaldi, Cushing and Lever, 1991*).

Longitudinal incidence studies are those repeated with the same population over time. The study by *Ayliffe et al (op cit)* could be regarded as longitudinal, although the authors do not describe it as such, because repeat studies were conducted in twelve of the original thirty-eight hospitals. This highlights the problem of classifying epidemiological studies in addition to comparing findings.

**Analytic Incidence Studies**

Analytic incidence studies are designed to test a hypothesis concerning the aetiology and risk factors for a particular disease (*Barker and Rose, 1979*). There are two types: case control studies and cohort studies.

The study by *French and Cheng (1991)* though described by the authors as a series of point prevalence surveys provides a typical case control approach. Having identified infected individuals (cases) the authors matched them with counterparts infection-free but otherwise as similar as possible (controls). Reviewing case notes of successfully matched patients revealed that those with HAI had significantly higher mortality rates, were likely to stay in hospital longer and receive expensive antibiotic treatment.

An acknowledged drawback of this approach is selection of appropriate controls (*MacMahon and Pugh, 1970*). *French and Cheng (1991)* were unable to match some of their infected patients, chiefly because they were so ill, and concluded that these probably represented instances of inevitable HAI, while those which could be matched were preventable.

Cohort studies are those in which a group of individuals are repeatedly reviewed to identify risks associated with disease. Although costly and time-consuming (*Farmer and Miles, 1983*), this approach appears feasible in hospitals where good patient records are held, as retrospective review of case notes and microbiology reports are possible, especially where the population is clearly defined (*Freeman, 1991*). *Gross et al (1980)* scrutinised factors contributing to mortality among one hundred patients each in two hospitals through retrospective analysis. Epidemiological patterns of HAI were similar in both although the patient populations were different. Where nosocomial infection clearly contributed to mortality it usually affected the lower respiratory tract. These patients could belong to the same category as the unmatched cases of *French and Cheng (1991)* believed to represent inavoidable HAI. Findings agree with those of other research teams (*Britt et al 1978; Scheckler 1978; Scott-Evans et al 1992*): those patients already most ill are also those most likely to succumb to HAI.

Similarly, repeated bacteriological studies among patients on a continuing care unit over a period of four years demonstrated that colonisation and infection with the opportunist Providentia stuartii tended to be associated with manipulations of the urinary tract (*Swiatlo, Kocka, Chittom et al, 1987*).

**Experimental Incidence Studies**

Studies falling into this category take the form of controlled trials, where one group of individuals receives an intervention, while an equivalent control group does not. Examples are difficult to find in relation to HAI, because of organisational and ethical constraints.

However, *Donowitz (1986)* used this approach to demonstrate that scrupulous hand hygiene but not gowning was of value in reducing incidence of HAI, while *Isaacs, Dickson, O'Callaghan et al (1991)* achieved similar results with an intervention comprising conscientious hand hygiene and segregation of infected cases. Both teams conducted their studies in paediatric units.

**Epidemiological Studies: Summary**

Overall the results of epidemiological studies suggest that HAI remains a major problem internationally and occurs most frequently among the very sick, contributing directly to mortality. Epidemic situations have been examined more than endemic conditions, although the latter are more likely to give a true representation of reality. The degree to which HAI can be prevented by intervention from the infection control team and infection control policies is considered in the next section.

**The Infection Control Nurse**

During the nineteenth century hospitals were avoided by those who could exercise choice because of their appalling conditions, which included high mortality from infection (*Selwyn 1991*). Improvements in hygiene and the development of aseptic techniques helped ameliorate this situation, but as technology advanced permitting more invasive techniques, HAI began to emerge as we know it today. Recognition of this growing problem led the *Medical Research Council (MRC) (1941)* to recommend hospitals to appoint designated members of staff to monitor nosocomial wound infections with a view toward prevention.

Three years later it was suggested that every hospital should establish a multidisciplinary committee to investigate cross-infection and develop preventative measures (*MRC 1944*). This was ignored until 1959, which was marked by widespread outbreaks of Staph. aureus. Need for action was reiterated and the Ministry of Health recommended the appointment of a Control of Infection Officer and a Control of Infection Committee in all acute hospitals. Simultaneously, the first infection control nurse was appointed in the UK in 1962 (*Gardner, Stamp, Bowger and Moore, 1962*). It is now a statutory requirement for hospitals to have an Infection Control Officer and Committee, but the appointment of an infection control nurse is not mandatory, although many hospitals employ them (*Grazebrook 1986*).

In the UK the role of the infection control nurse appears never to have been systematically evaluated, but according to *Worsley (1988)* the key to success lies in explicit statement of the functions of the individual post-holder. Opportunities for liaison with clinical microbiologists coupled with appropriate training are considered vital by this author, who believes that in the UK the appointment of infection control nurses has sometimes proved disappointing owing to vague job descriptions which lack clear goals, poor selection of recruits and limited input from clinical microbiologists. This can result in aimless collection of epidemiological data which, in the absence of pre-determined targets for prevention, cannot be used constructively. However, by involving clinical staff other appointees influence practice, developing nursing procedures and policies, teaching, and in some cases conduct research. Their role is distinct from that of medical microbiologists and augments the work of the infection control officer.

Suitable training is shown to enhance ability to perform surveillance effectively (*Mulholland, Creed, Dierauf et al, 1974; Glenister, 1990*).

In the USA the situation differs sharply, although infection control nurses were not introduced until the 1960's. Infection prevention is accorded high priority as hospitals cannot be given licence to practice unless they show demonstrably effective infection control policies in use, with a designated individual responsible for surveillance (*Grazebrook, 1986*). The SENIC Project (*Haley et al, 1985*) revealed that infection control nurses in conjunction with medical epidemiologists can prevent up to one third nosocomial infections. The essential components of an effective programme included one nurse for every 250 beds. Impact on rates of HAI was shown to decline with increase in the number of beds for which the nurse was responsible, until over 400 beds, she was deemed ineffective. Under these circumstances clinical areas known to be at particular risk (e.g. ITU) should receive priority (*Gaunt, 1991*). This is the situation most commonly encountered in the U.K. where the infection control nurse is usually responsible for more than 250 beds even in hospitals where more than one nurse is employed (*Worsley, 1988*) and in many other European countries (*Kallings, 1981*). Ways in which individual practitioners spend their time and prioritise activities has never been the subject of published investigation. However, education is widely accepted as part of the role (*Ashworth, 1984*), as is the development, implementation and distribution of infection control policies and standards. Their value in hospital is now considered.

**Infection Control Policies**

The key element of any infection control policy is that it should express its objectives succinctly in a manner readily understood by those expected to comply (*Simpson, 1991*). Success depends on a number of factors: overall presentation (e.g. whether specific information is easy to find), practicality (complicated advice may be ignored), availability of suitable equipment, and whether staff know about it. In Sweden a universal nursing and medical procedure manual incorporating infection control guidelines is used nationally, revised every five years and has been shown during formal evaluation to be widely accepted and appreciated by staff, especially nurse educationalists (*Nystrom, 1991*). National guidelines for many infection control issues have been developed in other countries, including the UK (Department of Health) and the USA (Centres for Disease Control - CDC), but in the UK legislation concerned with infection control tends to be less prescriptive than elsewhere. This is regarded as a strength by *Simpson (1991)*, because general guidelines are usually sufficiently flexible for modification according to local need. However, the manner in which they are incorporated into local policies may vary between hospitals, as may the quality of individual policies and the degree to which they are implemented. Much depends on the ability of the infection control nurse to communicate with colleagues (see *Wilson, 1990; Seto, Ching, Chu et al, 1991*). Advice may not be acted upon even when it is straightforward and involves little effort.

For example, *Whitby et al (1972)*, having traced an outbreak of Serratia marcescens to contaminated shaving brushes, found that staff continued to use communal brushes and soap after this practice had been banned. Their report is unusual in that few authors evaluate acceptance of recommendations. In the UK no mechanism for formal evaluation of infection control policies at national level exists, so weaknesses of guidelines and the manner in which they are implemented are not comprehensively established. Differences between hospitals where an infection control nurse is employed and a similar institution lacking a nurse could be usefully explored, particularly as a conscientious nurse may recognise gaps in guidelines and take steps to initiate action, either locally or, on a wider scale, by drawing them to the attention of her professional organisation, the Infection Control Nurses' Association.
*Miles (1991)* has drawn attention to glaring omissions in national infection control guidelines in the UK. Also problematic is the tendency of infection control specialists to take guidelines drawn up in one country as the basis for standards in another. In the USA CDC has developed guidelines for frequency of hand decontamination now adopted by authors in other countries (e.g. *Graham, 1990*). These are often quoted by British authors (see for example *Wilson and Breedon, 1990*), although different agents are popular in the UK (*Larson, Eke and Laughton, 1986*), some with cumulative effect (*Ayliffe, Babb, Davies et al, 1988*). This must influence optimal frequency of use.

**Standards**

*Simpson (1991)* comments on the achievements of the health care industry in the implementation of quality standards. If a product meets a standard specification and has been produced to a quality standard recognised by the British Standards Institution it can be awarded a kite mark. This benefits the manufacturer and the user as it ensures products of consistent quality. Faults during manufacture can be traced to establish the cause, so it is possible to withdraw items from a defective batch. Hospital purchasers usually demand British Standards as the basis for informed selection.

British Standards exist for many items of hospital equipment vital for infection prevention such as sharps boxes (*Gwyther, 1989*), but not gloves (*Jenner, 1990*), although these are subject to defects which reduce effectiveness, including splitting (*Dalgleish and Malkovsky, 1988*) and leakage (*Korniewicz, 1989*).

Hand disinfectants feature among products for which no nationally agreed test methods exist, although *Simpson (1991)* believes that there is need for international standardisation. At present manufacturers seeking product licences from the Department of Health produce a range of test data for antimicrobial efficacy, but exclude other factors such as cosmetic acceptability. These issues are considered further in Chapter Three.

**The role of policies, standards and the infection control nurse in infection prevention: summary**

In Britain policies for infection prevention have been developed, but appear not to be as rigorously implemented as in some other countries, with no overall strategy for evaluation. Infection control emerged as a nursing specialty in the UK, but the role now seems less well developed than in the USA. National standards for numerous vital infection control activities exist, but there are some major omissions, notably gloves.

Local infection control policies contain information concerning specific clinical procedures, but prevention also depends on knowledge of bacterial growth requirements, transmission and portals of entry. These are considered in Chapter Two.

# CHAPTER TWO

## THE SOURCES AND DISSEMINATION OF BACTERIA IN THE HOSPITAL ENVIRONMENT

Chapter One introduced the topic of HAI and explored the role of infection control policies and standards. This chapter is concerned with the dissemination and behaviour of micro-organisms responsible for HAI. *Reybrouck (1983)* argues that understanding the constituents of normal skin flora is crucial because this provides the knowledge necessary to understand the significance and incidence of extraneous bacteria, especially on hands, paving the way for effective hand hygiene protocols. However, there is lack of consensus over the composition of normal flora in healthy or sick people (*Schaechter, 1989).*

### Normal Skin Flora: Constituents

Extensive studies summarised by *Noble and Sommerville (1974)* suggested that most bacteria on the skin are coagulase negative staphylococci and corneybacteria, then generally regarded as harmless. Views have since changed, as <u>Staphylococcus epidermidis</u> is now known to be a potential, though opportunistic, pathogen, able to cause clinical infection among the immunocompromised. It is now recognised as a leading cause of bacteraemia and may become antibiotic- resistant (*Thurn, Crossley, Gerdts et al, 1992*). The role of coagulase positive staphylococci as wound pathogens was recognised in the 1950's (see Chapter One). It became apparent that in addition to causing clinical infection <u>Staph. aureus</u> could be carried asymptomatically by patients before they underwent surgery (*Polakoff, Richards, Parker et al, 1967*) and by members of the general population who had not recently been in hospital (*Noble, Valkenburg and Wolters, 1967*).

Originally Gram negative rods were not believed to form part of the normal skin flora, but *Stratford, Gallus, Matthieson et al (1968)* provided evidence that medical and surgical patients could become colonised, with these bacteria potentially able to contribute to HAI, a suggestion which has since been verified (*Montgomerie and Morrow, 1980*). Gram negative bacteria are more resistant to antibiotics than the skin flora of healthy adult members of the general population (*Larson, McGinley, Foglia et al, 1986*). The length of time they could persist on intact skin became a matter of considerable debate.

**Transient and Resident Flora**

*Price (1938)* distinguished between "resident" and "transient" bacteria through quantitative laboratory handwashing studies. Those organisms which could eventually be removed by repeated and thorough handwashes were categorised as transient, thought at the time to represent contaminants which under normal circumstances would probably die within 24 hours of inoculation. The remaining resident bacteria, regarded as the true skin flora, persisted deep in the ducts of sweat glands and subungual spaces. The existence of transient and resident hand flora on the basis of whether or not they can be removed by strict handwashing has since been verified by *Hann (1973)* and *Gross, Cutright, McGinley et al (1979)*, but it has become apparent that contaminants, especially Gram negative species, may be carried for weeks or months by nurses (*Cooke, Edmonson and Starkey, 1981; Larson, 1981*). Hand carriage among approximately 20-30% of hospital staff has been reported (*Bruun and Solberg, 1973; Adams and Marrie, 1982*), but isolation rates of up to 80% have been mentioned in relation to neonatal and burns units (*Knittle, Eitzman and Baer, 1975*).

Evidence reviewed in Chapter Three shows that this may contribute to endemic and epidemic colonisation and infection.

**Density and Distribution**

Discrepancy reigns over the density of bacteria found on different parts of the skin. A biopsy method developed and described as sensitive by *Selwyn and Ellis (1972)* suggests that density varies greatly according to anatomical location, but detailed findings remain open to debate, because the samples were taken from cadavers. However, results are probably superior to studies with surviving patients, because these have employed a method of washing the skin surface. Bacterial count may vary with dilution. A third approach employed by some authors in the studies reviewed by *Noble and Somerville (1974)* involved pressing culture media directly onto skin. From this research it appears that counts are particularly high on the forehead and between fingers and the webs of toes, especially if there is evidence of disease. Although the limbs and trunk account for a much greater surface area, they appear to harbour fewer bacteria. *Ojajarvi, Makela and Rantasalo (1977)* pointed out that nurses' hands are most likely to become colonised by extraneous bacteria when they are continually moist or damaged, cracks and small wounds probably allowing organisms to establish a foothold in underlying tissues. Their view is shared by *McBride, Duncan and Knox (1975)* who demonstrated in two highly controlled laboratory studies that survival of Gram negative bacteria on skin was related to temperature and humidity as well as exposure of the subject to antibiotics.

There was some variation in results among the healthy volunteers who participated in these studies, although the same test bacteria were used, indicating that complex physiological factors related to host and bacterium govern skin flora and the delicately balanced ecosystem by which commensals keep extraneous strains at bay.

Research concerning factors which may promote hand carriage among hospital staff is gaining impetus. Wearing rings increased carriage, chiefly Gram negative bacteria, on underlying skin during field studies (*Hoffman, Cooke, McCarville et al, 1985*), but laboratory studies suggest that thorough washing can reduce counts to levels recorded among volunteers not wearing rings (*Jacobson, Thiele, McCune et al, 1985*). Glovewearing also increases counts (*McGinley, Larson, Leyden et al, 1988*). These points deserve further investigation in view of their clinical significance.

The above discussion implies that bacteria remain static at a particular anatomical location, but this is known to be untrue, especially when patients are exposed to instrumentation and invasive procedures. Transfer can occur from one site to another: during epidemics bacteria responsible for urinary tract infection have been identified from distant sites, including patients' hands, knees and groins (*Casewell, Dalton, Webster et al, 1977*). The damp perineal skin of patients with spinal cord injuries may become colonised with coliforms (*Sanderson and Weissler, 1990*). Migration into the bladder via a urinary catheter may result in bacteriuria (*Sanderson and Rawal, 1987*).

The following sections review the significance of Gram negative rods and Staph. aureus as potential pathogens rather than harmless commensals. In both cases there is sufficient circumstantial evidence to demonstrate spread primarily via the contact route, with hands, the part of the body in most continuous contact with patient and environment, playing a major role. Airborne dissemination is much less significant (*Ayliffe and Lowbury, 1982*). The inanimate environment has little influence on rates of HAI (*McGowan, 1981*), but patients with invasive devices are at particular risk (*Rose and Babcock, 1975*). However, direct evidence of the hands as primary vectors of HAI is scarce.

*Larson (1988)* remarking on the paucity of prospective clinical trials to test a causal link between hand hygiene and HAI attributes their absence to pioneers of the mid nineteenth century (Semmelweis, Lister and Nightingale) who effected such dramatic reductions in morbidity and mortality from infection by implementing hygiene into health care that antisepsis has too long been recognised beneficial for research withholding it to be considered viable on ethical grounds.

Most evidence comes indirectly from uncontrolled trials and small scale epidemiological studies. Evidence which implicates hands directly must be drawn from community studies concerned with enteric pathogens and respiratory viruses in institutional and non-institutional settings.

**Direct Evidence of the Hands as Vectors of Infection**

A controlled trial by *Black et al (1981)* demonstrated a critical link between hand hygiene and risk of infection. Building on work by *Pether and Gilbert (1971)* which demonstrated the ability of enteric pathogens to survive on fingertips for up to ten minutes following minimal inoculation (6,000 organisms), *Black's* team demonstrated a sharp decline in the incidence of diarrhoea over 35 weeks among children in two day nurseries following the introduction of a strict staff handwashing regime. No reduction occurred in two control centres. Counts of enteric pathogens were significantly reduced on the hands of staff in the experimental nurseries. Reduction of Rotavirus occurred although it is commonly regarded as an airborne pathogen. Its spread by the contact route is further indicated by *Samandi, Huq and Ahmed (1983)* who detected virus particles in the handwashings of staff attending children with diarrhoea.

Further evidence that classic "airborne pathogens" depend heavily on spread by direct contact has also provided evidence of the efficacy of handwashing.

Laboratory tests by *Gwaltney, Moskalski and Hendley (1978)* demonstrated efficient transmission of Rhinovirus from experimentally infected volunteers to recipients via hands in eleven out of fifteen exposures, significantly more often than via aerosols. It was suggested that once hands become contaminated, self inoculation to the nasal mucosa occurs when the face is touched (*Hendley, Wenzel and Gwaltney, 1973*).

In later trials *Leclair, Freeman and Sullivan (1987)* showed that strict glove and gown precautions could reduce transmission of respiratory syncitial virus (RSV) by a quarter when staff compliance was high. Virus particles could be recovered from the environment, including door handles and other items which are frequently touched. They were probably deposited in nasal secretions. Recently *Isaacs et al (1991)* reduced the incidence of nosocomial RSV among severely ill children through a regime of cohorting and encouraging staff and parents to wash hands. These findings support *Donowitz's (1986)* finding that hand hygiene but not gowns reduced the incidence of HAI in a neonatal ward.

Having discussed these studies it is now possible to examine Gram negative bacteria and Staph. aureus for evidence of pathogenicity and dissemination by contact.

**Gram Negative Bacteria**

Once staphylococcal infections had been controlled by pharmaceutical developments during the 1960's, clinical microbiologists began to comment on the increasing number of colonisations and infections caused by Gram negative rods. Initially these involved critically ill patients, especially those with invasive devices (*Harris, Orwin, Colquhoun et al, 1969*). A classic study by *Lowbury, Thom, Lilly et al, (1970)* dating from this era continues to be widely quoted because its findings illustrate the typical behaviour of Gram negative rods so effectively. Observations with Pseudomonas aeruginosa conducted over twenty months in ITU demonstrated sporadic epidemics caused by different phage and serotypes, with no evidence that any particular upsurge was related to earlier peaks in colonisation or infection.

Items in direct patient contact (washbowls, nailbrushes) were frequently contaminated with strains recovered from patients, but not furnishings and fittings at distant sites, including floors and sinks.

Although nurses' hands became colonised, the introduction of gloves had no influence on sepsis rates, possibly through breakdown in hand hygiene protocols when the unit became busy.

With the passage of time other Gram negative species emerged as potential pathogens, including some formerly regarded as harmless saprophytes (*Setia and Gross, 1977; Swiatlo et al, 1987*), and outbreaks were reported from less acute clinical settings (*Moody et al, 1972; Curie et al, 1978*). In these studies patients tended to become colonised before developing clinical infection. Antibiotic resistance rapidly became a problem (*Marks, Bruten and Speller, 1977*).

As Pseudomonas and other Gram negative bacteria established themselves as the scourge of hospitals, attempts were made to explain their success in clinical and epidemiological terms. *Pettit and Lowbury (1968)* established their ability to survive in minute traces of moisture with minimum nourishment, suggesting why they had become so successful throughout the damp hospital environment. They were also shown to be physiologically robust: survival was possible in disinfectant solutions (*Phillips, Eykyn, Curtis et al, 1971*) and soaps intended to contain spread (*Jarvis, Wynne, Enwright et al, 1979; Graf, Kersch and Scherzer, 1988*).

The ability of particular Gram negative bacteria to colonise moist environments and develop into potential reservoirs of infection is the topic of a standard text containing a wealth of detail on prevention through the promotion of clean, dry conditions (*Maurer, 1985*). Although this material is valuable to staff concerned with the maintenance of a safe hospital environment, control is not guaranteed because some strains of Gram negative bacteria are able to withstand a degree of desiccation and this greatly enhances pathogenicity.

Early studies summarised by *Lowbury (1969)* indicated that although most Gram negative rods rapidly succumb through drying when deposited onto human skin, a few strains survive. The author deduced that these must be responsible for cross infection. *Lowbury's* conclusion is echoed in the laboratory findings of later authors. *Filho, Stumpf and Cardoso (1985)* confirmed that over 99% Pseudomonas, Serratia, Klebsiella and E. coli died within two minutes of application to the finger tips of volunteers, but $10^5$ cells remained viable ninety minutes later. On wards these numbers could be sufficient to result in cross infection over this period of time. There was considerable variation between species. Klebsiella was most strongly resistant to desiccation, followed by Pseudomonas, then Serratia. Least tolerance was displayed by E. coli. These experimental findings help to explain the results of epidemiological studies: Klebsiella and Pseudomonas are responsible for more outbreaks of nosocomial infection than E. coli. Building on this work *Cooke et al (1981)* established that species and strains previously responsible for hospital outbreaks were able to survive significantly longer than "non-outbreak" bacteria when artificially inoculated onto the finger-tips of laboratory volunteers. Collectively these studies indicate that bacterial transfer can occur between hands and patients.

**The Hands as Vectors of Gram Negative HAI**

*Reybrouck (1983)* emphasises that isolation of the same bacterial strains from patients and the hands of hospital staff reported in numerous studies (see *Preston et al, 1981*) does not constitute absolute proof of cross infection, but it is highly suggestive, especially today with sensitive methods of serotyping bacteria, and evidence of successful control of outbreaks once a strict handwashing regime has been implemented. Persuasive evidence for the hands as vectors of hospital-acquired Gram negative sepsis is provided by *Casewell and Phillips (1977)* who demonstrated that 17% staff in ITU had Klebsiella hand contamination of the same serotypes as those colonising patients.

Laboratory experiments showed that bacteria remained viable for up to 150 minutes following artificial inoculation onto the hands - sufficient time for cross infection to occur during normal nursing duties. Clothing, ward air and dust samples were seldom contaminated, supporting work reviewed earlier by *Noble, Habbema, Van Furth et al (1976)* which concluded that although some individuals disperse Gram negative bacteria heavily, there is no evidence to support airborne spread. Continued work over a four year period demonstrated that 24% of 2,315 critically ill patients became colonised with Klebsiella, almost always with the same capsular strains (*Casewell and Phillips, 1978*). Possession of a thick mucus capsule, not carriage of an antibiotic-resistant plasmid, was apparently the influential factor in bacterial survival on finger tips (*Casewell and Desai, 1983*). This finding is in keeping with the results of laboratory studies reviewed above, as the mucus would help prevent desiccation.

Field work conducted in a urology ward is frequently quoted because it illustrates so many features of typical Gram negative behaviour (*Casewell, Dalton, Webster et al, 1977*). Gentamicin-resistant Klebsiella aerogenes was isolated from the urine of 17 out of 237 patients admitted over three months, chiefly those who were catheterised and already receiving antibiotics. The epidemic strain was isolated from numerous skin sites and was finally eradicated by a combined regime of isolation, stringent handwashing and use of plastic aprons. One nurse carried bacteria for 62 days after leaving the ward, emphasising the ability of Gram negative rods to colonise skin long term. In contrast, *Curie et al (1978)* documenting an outbreak of the same species, also a mucus-encapsulated strain, seldom isolated bacteria from the hands of staff except immediately after handling heavily colonised patients. However, hand carriage was regarded as influential in dissemination, as strict handwashing and glove use curbed the outbreak. Bedpans and urinals were suggested as likely fomites because the bedpan washer was out of order during this time and urinals were ineffectively disinfected in a tank.

When long stay patients are catheterised their hands may become a source of Gram negative bacteria, as may the hands of nurses attending them *(Sanderson and Weissler, 1992)*. The immediate patient environment (wheelchairs, towels, bedclothes, flannels) also becomes contaminated *(Sanderson and Rawal, 1987)*. Spread may occur by cross infection and at least one outbreak has been halted on a neonatal unit through suspension of a nurse found to be a long term Gram negative carrier (*Burke, Ingall, Klein et al, 1971*). Although patients' hands may be contaminated with bacteria (*Pritchard and Hathaway,1988*), this has yet to be associated with an outbreak.

In Chapter One the contribution of extraordinary circumstances to the development of bacterial outbreaks was commented upon. Such reports sometimes assume exaggerated importance because of the tendency of clinical microbiologists to submit them to journals and the subsequent tendency for readers to remember and in turn quote their striking findings. There is some evidence of this in relation to Gram negative sepsis. Room humidifiers have been implicated in an outbreak of Acinetobacter, with air, not hands reported as the source (*Smith and Massanari, 1977*). Possibly of greater interest because more relevant to everyday endemic situations, is the apparent ability of Acinetobacter to survive on inanimate surfaces as well as hands (*Musa, Desai and Casewell, 1990*). It is now acknowledged that survival in dust may be possible for this genus, so cross infection via air or fomites in the case of Acinetobacter cannot be ruled out *(Hirai, 1991; Schaal, 1991)*. However there is abundant, though indirect, evidence that most Gram negative bacteria in hospital are spread chiefly by direct contact.

**The Significance of Gram Negative Colonisation and Infection**

In the majority of the studies reviewed above patients became colonised more frequently than infected and both colonisation and infection occurred most readily among the very debilitated. This has called into question whether the presence of Gram negative rods should be a cause of concern and whether stringent programmes of control are wholly justified. The need for control is illustrated through a descriptive prospective study by *Johanson, Pierce and Sandford (1972)*, who showed that of two hundred and thirteen patients admitted to ITU, 45% became colonised, generally those who were most ill (leucopenic, acidotic and unconscious).

Possibly these could be equated with the unmatchable individuals in the study by *French and Cheng (1991)* outlined in Chapter One: they represented inevitable victims of Gram negative colonisation because they were so ill. Despite the established relationship between antibiotic treatment and colonisation, 22% had already become colonised by the end of their first day in hospital and of these twenty-six (12.2%) developed HAI. It is this client group which demands most in terms of health care resources (*Daschner, 1985*), although at the time this author was writing they accounted for only 8% of admissions. Today advances in technology prolong the lives of these very sick people, in conjunction with ever increasing use of the invasive procedures and devices which are chiefly responsible for sepsis (*Tafuro and Ristuccia, 1984*). As long as they survive they operate as reservoirs of infection for the rest of the hospital (*Blenkharn and Hughes, 1982*). Neither infection or colonisation can be considered hallmarks of good medical or nursing care (*Nystrom, 1991*).

**Staphylococcal Infections**

Originally streptococci were implicated in many outbreaks of HAI, observed by contemporary writers (*Goodall, 1952*) and in later archival work (*Selwyn, 1991*), but during the 1950's staphylococci became recognised as responsible for outbreaks (*McDermott, 1956*), while their ability to develop antibiotic resistance became increasingly problematic (*Colebrook, 1955*).

**Evidence for the Hands as Vectors of Staphylococcal Infection**

Early work focused on air dissemination via skin scales as a possible route of spread, particularly from members of staff identifiable as "heavy dispersers". Experiments with preclinical medical students demonstrated that approximately 14% of the male population acted as persistent perineal carriers of Staph. aureus. Dispersal of free bacteria into the air could occur during exercise in a special chamber (*Ridley, 1959*), but under normal circumstances they would probably become attached to clothes.

Nasal carriage was reported as more widespread, but field and laboratory studies indicated that dissemination usually occurred not directly through the air in droplets, but by an indirect route in which nasal secretions were first found to contaminate skin, clothing and probably hands (*Hare and Thomas, 1956*). It was suggested that limited transfer might occur via friction or air currents, but later investigations involving the use of a slit sampler to detect airborne transmission during a major staphylococcal outbreak revealed that if this occurs at all, it operates over only very short distances (*Peacock et al, 1980*). In this study the hands of staff emerged as the major vectors and retrospective chart analysis confirmed that patients who became colonised or infected were usually taking antibiotics and were very ill.

The classic experiments of *Ridley (op cit)* and *Hare and Thomas (op cit)* led to a series of field studies by *Mortimer, Wolinsky, Gonzaga et al (1966)*. These were conducted in a neonatal unit to trace spread of staphylococci and streptococci from babies already colonised between nurses and other infants.

There was minimal spread from nurses to infants who were in proximity but not touching. When contamination via the airborne route was theoretically prevented, a 43% transmission rate occurred from colonised to previously uncolonised babies providing the nurse did not wash hands between contacts. Antiseptic handwashing reduced transmission rate to 14%.

The introduction of new synthetic penicillins brought dramatic improvements in the treatment of Staph. aureus throughout the 1960's but this allowed complacency to develop and promoted the emergence of multiply- resistant strains (*Cafferkey, Coleman, McGrath et al, 1985*). Consequently the 1970's and 1980's have been punctuated by repeated outbreaks of methicillin resistant Staph. aureus (MRSA) throughout the world (*Bradley, Noone, Townsend et al, 1985; Hanifah, Hiramatsu and Yokota, 1992*). Epidemiological studies confirm that, as with Gram negative bacteria, colonisation precedes infection with the most sick patients operating as reservoirs and transfer occurring chiefly via hands (*Thompson et al, 1982*). Policies for control vary according to available facilities and circumstance (*Spicer, 1984*), ranging from very aggressive to more moderate approaches. Success is frequently evaluated in published articles although according to *Goetz and Muder (1992)*, this tends to focus on short term effectiveness only. However, some long term assessment has been recorded. Despite heroic efforts on the part of the infection control nurse and handwashing campaigns, MRSA is now considered endemic in at least one major acute hospital, following introduction ten years ago (*Faogali, Thong and Grant, 1992*). Nurses and other members of staff with close patient contact can become asymptomatic carriers (*Shanson, 1985*), especially those employed in theatre, surgical wards and ITU (*Na'was and Fakhoury, 1991*).

This contributes to risks of cross infection unless treated and, in questionnaire studies conducted by occupational health staff, remains a cause of concern to nurses, anxious on behalf of their patients (*Tuffnell, 1988*) and themselves (*French, 1987*). Major concerns documented included the risk of spread to susceptible patients, correct implementation of policies and distress engendered through enforced sick leave if colonised. Nurses who had cared for patients with MRSA complained of sore, dry hands through the need for frequent decontamination (*Tuffnell, 1988*).

Although MRSA contributes directly to morbidity and mortality (*Locksley, Mitchell, Cohen et al, 1982; Tuffnell, Croton, Hemingway et al, 1987*), attitudes towards containment vary. According to one school of thought MRSA offers no special threat in hospital compared to other agents responsible for HAI. The alternate view is that MRSA should be stringently controlled.

**The Significance of MRSA Colonisation and Infection**

Evidence that MRSA has become endemic in some hospitals (*Faogali et al, 1992*) could be used to support an earlier view put forward by *Lacey (1987)*: MRSA need not be considered a major threat because, like many Gram negative bacteria, it is a weak pathogen, forming part of the body's normal commensal flora, usually responsible for colonisation rather than overt infection. When clinical infection supervenes, *Lacey (op cit)* argues, those affected tend to be the elderly and very sick, where prognosis is already poor - again, the unmatchable cases of *French and Cheng (1991)* whose condition is such that HAI appears inevitable.

Early clinical observations suggested that some strains might be less virulent than others (*Aielts, Sapico, Canawati et al, 1982*). This has since been verified in laboratory studies (*Cookson and Phillips, 1988*). However it has now been suggested that although MRSA is a heterogenous group of bacteria still responding to the selective pressures of antibiotic exposure in different centres, all appear to share the common characteristic of ready dissemination (*Keane, Coleman and Cafferkey, 1991*) which may be explained by factors related to virulence (*Phillips, 1991*). Moreover many strains, as well as showing epidemic potential (EMRSA), are highly pathogenic. By tabulating data from a number of studies *Casewell and Hill (1986)* showed that under appropriate circumstances MRSA could achieve full pathogenic potential, producing clinical infection in addition to colonisation. This is illustrated by the study conducted by *Tuffnell et al (1987)* in a district general hospital involving one hundred and fifty-one individuals, most of whom became colonised rather than infected. Although there were only two mortalities, morbidity - which took the form of discharging wounds, otitis media, urinary tract infections and pyrexia - was of a kind guaranteed to reduce quality of life and can scarcely be sanctioned on humanitarian grounds. In addition, at the peak of the outbreak forty-three cases occurred within three months, contributing enormously to nursing and medical workload and reducing the amount of time available for other patients. On this basis it is not possible to concur with *Lacey (1987, p. 219)* that MRSA carriage "Might be tolerated in certain groups ...patients such as the elderly". Older people frequently undergo surgery, particularly orthopaedic implantation, which falls into the very high risk category, with catastrophic consequences in the event of deep joint sepsis (*Scheibel, Jensen and Pedersen, 1991*).

Although antibiotic treatment with vancomycin is possible it is undesirable as the drug exerts marked and unpleasant side effects (*Sorrell, Packham, Shunter et al, 1982*).

Many authors evidently consider stringent control measures advisable for MRSA on wards, judging by the time-consuming observational studies conducted to determine more precisely the mechanisms of dissemination. Nurses who become most heavily colonised are those with very close patient contact (*Cookson, Peters, Webster et al, 1989*). Transfer from patient to nurse possibly occurred in this detailed study when unwashed hands touched the nurse's face and nose, paralleling the mechanism suggested for Rhinovirus (*Hendley et al, 1973; Gwaltney et al, 1978*).

This behaviour was documented many times despite intensive preventative campaigns emphasising hand hygiene and nurses' awareness of the purpose of observation. Most staff became transient carriers, but a few cases of more permanent colonisation were documented. Treatment with mupirocin avoids long periods of enforced sick leave, although staff should cease patient contact until free of MRSA (*Cookson, Farrington, Webster et al, 1985*).

**Hands and the Inanimate Environment**

A series of studies (*Smylie, Davidson, McDonald et al 1971; Smith, Logie, MacDonald et al, 1974*) revealed a reduction in post-operative wound infection from 65% to 40% following a move from "Nightingale" premises to a ward of "racetrack" design with more beds in single rooms and greater control of ventilation.

These findings have never been replicated. *Huebner, Frank, Kappstein et al (1989)* could detect no difference in rates of HAI, sites affected or causative agents following a similar move, this time from an old ITU constructed in 1924 to a purpose-built unit. *McGowan's (1981)* extensive literature review could find no evidence in support of the inanimate environment influencing HAI, and this is confirmed by *Maki, Alvardo, Hassemer et al (1982)* in a "natural" experiment possible when an entire hospital moved from old to new, better equipped and ventilated premises. The new environment became contaminated so rapidly that these authors suggested that people acted as the chief reservoirs and that routine surveillance of the inanimate environment could not be considered a worthwhile undertaking.

Studies presented in Chapter One demonstrated that hospital floors rarely contribute to HAI. The ability of sinks to operate as reservoirs for Gram negative strains is more contentious. *Brown and Baublis (1977)* identified sinks as among the chief reservoirs for Pseudomonas in a neonatal unit: colonisation occurred among those infants whose equipment was sufficiently close to become splashed. More than six feet away from the sinks there was no evidence of contamination. Much colonisation was due to contact spread, however, as use of gloves led to a decrease in colonisation. Other authors find little relationship between colonised sinks and rates of HAI *(Levin, Olson, Nathan et al, 1984)*.

From time to time interest has been shown in the water of flower vases as a potential reservoir. Plants may be heavily contaminated with Gram negative rods originating in soil (*Taplin and Mertz, 1973)* but transfer to patients is not generally a cause for concern (*Schroth, Cho and Kominos, 1973; Kates, McGinley, Larson et al, 1991*).

Much depends on what is arbitrarily considered the immediate patient environment. This may depend on how mobile patients are and whether their condition permits them to handle potential fomites. *Speller, Raghunath, Stephens et al (1976)* recovered bacteria from bedside curtains during an outbreak in ITU. Perhaps of greater relevance to the endemic, everyday situation, *Sanderson and Weissler (1992)* found coliforms on wheelchairs, bedside tables and towels of patients with orthopaedic conditions. These were of the same type as strains on nurses' and patients' hands. Under these circumstances it would be reasonable to predict recovery from other environmental objects frequently handled by nurses such as telephones and light switches, but a carefully planned prospective incidence study in ITU found that they persisted in relatively low numbers (*Rose and Babcock, 1975*). In this study and many others, indwelling tubes acted as the principal reservoirs.

**Links between Faulty Hand Hygiene, Equipment and HAI**

Invasive devices bypassing the body's natural barriers to micro-organisms vastly increase risks of HAI *(Tafuro and Ristuccio, 1984)*. *Mulhall (1990)* points out that although doctors are usually responsible for siting intravenous cannulae, catheters and endotracheal tubes, nurses look after them, providing care which though routine, is complex. Rates of infection related to particular types of equipment show considerable variation according to the findings of an extensive multicentre incidence study (*Nystrom et al, 1983*), although there is little doubt that high dependency patients undergoing many procedures are at greatest risk (*Daschner, 1985*). There is also evidence that risk of sepsis is increased when new techniques are introduced with which staff have limited experience.

A prospective survey by *Dumas et al, (1971)* drew attention to high levels of contamination associated with intravenous volume control sets linked to poor maintenance (leakage, dirty injection ports) and breaches in asepsis, especially handwashing. Later prospective studies recorded lower infection rates explained through new, less easily contaminated designs of equipment and the simultaneous development of strict protocols for asepsis (*Buxton, Highsmith and Garner, 1979); Shinozaki et al, 1983; Leroy, Billau, Beuscart et al, 1989*). Where aseptic technique broke down, infection was more likely to supervene. This evidence lends weight to HAI being dependent mainly on the contact route for spread, with hands, which manipulate equipment, playing a vital role.

**Chapter Two: Summary**

This chapter has explored likely sources of Gram negative and positive bacteria in hospital and examined possible mechanisms of dissemination, concluding that for both groups contact spread, particularly via hands, provides the major route. Infection seldom reaches patients in general wards from the inanimate environment or via the air, but poor hand hygiene provides the link between equipment, particularly invasive devices, the environment and the patient.

In the next chapter the role of hand hygiene in the control of HAI is considered in greater depth.

# CHAPTER THREE

## THE CONTROL OF HAI: THE ROLE OF HAND DECONTAMINATION AND PROTECTIVE CLOTHING

Strategies most commonly employed to control HAI include antibiotics and isolation precautions for infected and heavily colonised patients (*Weinstein and Kabins, 1981*). Their drawbacks are well documented. Excessive use of antibiotics may promote the selection of resistant strains (*Olson, Weinstein, Nathan et al, 1985*), while isolation is distressing for patients (*Bagshawe, Blowers, Lidwell, et al, 1978; Geelhoed 1978; Genvert, Thiel, Levy-Zombek et al, 1979; Ketcham, 1981*). The value of hand decontamination is sometimes overlooked, although the results of field and laboratory studies repeatedly indicate that it is the single most effective means of containing HAI, a suggestion which should be welcomed as it is relatively uncomplicated and inexpensive compared to other measures (*Lowbury et al, 1970; Larson, 1988*). In comparison, complicated protocols involving the use of protective clothing are far less valuable on general wards.

### Hand Decontamination

The purpose of hand decontamination is to remove all transient micro-organisms below the level necessary to constitute an infective dose before transfer can occur to a susceptible patient (*Ayliffe, Babb and Quoraishi, 1978*). This can be achieved with soap and water or medicated agents (*Lowbury, Lilly and Bull, 1964*). Its purposes and technique are distinct from those of surgical scrubbing, which involves prolonged, extremely thorough handwashing so that resident as well as transient bacteria are reduced to the lowest possible counts.

It may be necessary for the effects of surgical scrubbing to last for several hours (*Dineen, 1978; Bendig, 1990*), but in wards risks accrue as nurses move from one patient to another, or handle different sites involving the same patient, so decontamination should occur between. Gloves are worn for much longer in theatre inducing sweating (*Peireira, Lee and Wade, 1990*), known to have the effect of increasing total bacterial skin count because sweat may "leach out" bacteria from the subungual spaces, where density is greater than elsewhere on hands (*McGinley, Larson and Leydon, 1988*). Glove puncture is a common event in theatre (*Brough, Hunt and Barrie, 1988; Hussain, Latif and Choudhary, 1988*), so there is risk of inoculation into the patient's tissues. Methods for evaluating the effectiveness of surgical scrubbing must therefore take into account the subungual bacterial population, but for hand decontamination as it is practised by nurses on hospital wards, their presence can be ignored (*Leyden, McGinley, Kaminer et al, 1991*). However, the literature is sometimes confusing as many hand decontaminants are considered suitable for both procedures (*Mitchell and Rawluk, 1984*).

This chapter will focus on hand decontamination as it should be performed on wards by nurses when there is neither time or need for surgical scrubbing. Its evaluation is a complex process comprising selection of appropriate agent, frequency, duration, appropriateness (whether hands are decontaminated when necessary) and quality of technique (*Larson and Lusk, 1985*). In her extensive review of the ~~literature published 1879-1986 *Larson (1988)* concluded that the majority~~ of studies were concerned with developing and testing agents, while behavioural studies accounted for only 10%.

Nevertheless there is evidence that all components of the hand decontamination process tend to be poorly performed.

**Hand Decontaminating Agents**

Many laboratory studies have been conducted to evaluate the effectiveness of different hand decontaminants. Protocols have become extremely complicated and the literature is replete with discussions of the best laboratory model, with heated debate likely to continue (*Ayliffe, Babb, Bridges et al, 1975; Rotter, Koller, Wewalka et al, 1986; Rotter, 1988; Holloway, Platt, Reybrouck et al, 1990; Journal of Hospital Infection, Letters to the editor 1990, p.189*). This may reflect lack of International Guidelines for hand decontamination (see Chapter One).

**Advantages of Medicated Agents**

Some authors acknowledge that tightly controlled laboratory conditions are not intended to reflect everyday clinical activities (*Larson, Eke, Laughon, 1986; Ayliffe, Babb, Davies et al, 1990*). This is reflected in the longer time that hand decontamination continues in the laboratory compared to wards and the tendency to select healthy young volunteers whose skin is in good condition. Evidence reviewed below indicates that hands of hospital personnel are often damaged by repeated washing. However, studies simulating the clinical situation or incorporating fieldwork for direct comparison to laboratory findings are probably most helpful when decisions concerning suitable agents for routine ward work are made. A study by *Ayliffe, Babb, Davies and Lilly (1988)* using E. coli as the test organism indicated that in the laboratory and clinical situation chlorhexidine is superior because it has residual effect. Alcoholic preparations reduce transient bacterial counts more swiftly, although their action does not persist.

The efficacy of these two agents in combination has been demonstrated by *Rotter and Koller (1990)*: the addition of emollients increases acceptability to staff and does not reduce bactericidal effectiveness (*Rotter, Koller and Neumann, 1991*).

The difficulty of performing field trials with decontaminating agents has been discussed by *Larson (1984)*. There are too many conflicting variables for precise control. This author points out that the key indicator of efficacy is the mean percentage reduction in total flora on the hands rather than organisms remaining after washing. This is difficult to determine unless the number of CFU on hands is known before as well after decontamination.

In view of these difficulties, very few field trials have examined the influence of decontaminating agents on HAI but there have been attempts to monitor infection rates while performing intervention studies. Of the two recently reported within the literature, one supports use of chlorhexidine in the clinical situation, while the other does not.

The first of these studies, one of the most comprehensive and detailed ever published, took the form of a prospective, multiple crossover trial involving 1894 patients in three intensive care units (*Doebbeling, Stanley, Sheetz et al, 1992*). Each unit in turn used chlorhexidine, 60% isopropanol or a broad spectrum antimicrobial gel with soap. Each intervention lasted for one month while rates of HAI and hand decontamination compliance were monitored. When chlorhexidine was available HAI declined sharply on each unit and decontamination occurred significantly more often.

The authors considered that reduced infection was probably associated with increased compliance and reported that staff did not comment on hand soreness in conjunction with chlorhexidine, a result at odds with the second field trial by *Webster (1992).*

This author, collecting data over a seven week period in a neonatal ward in Australia, found that MRSA colonisation declined from an average incidence of 3.4 cases per week to 1.4 ($p$ <0.0001) when 1% hexachlorophene replaced chlorhexidine. Questionnaire data indicated that staff received hexachlorophene favourably because chlorhexidine had damaged their hands.

Hexachlorophene has fallen from favour in the UK because it can be absorbed into the blood via skin and has been related to C.N.S. impairment in neonates, emphasising that decontaminants are capable of exercising toxic, highly undesirable side effects.

### Disadvantages of Medicated Agents

The study of *Doebbeling et al (op cit)* has been criticised by *Goldmann and Larson (1992)*, who claim that despite a very aggressive campaign to promote hand decontamination, their highest level, 42% compliance with chlorhexidine, is still of dubious value on the basis that no medicated agent is of benefit unless used continuously so the effectiveness of some other agent cannot be ruled out. Their opinions are not easily dismissed in the light of *Gidley's (1987)* observation that of thirty-three ward handwashing episodes, only four were performed with chlorhexidine in preference to soap, while ten involved the use of water alone.

Chlorhexidine has been criticised because it is harsh, damaging skin and increasing bacterial counts, with potential risk for more cross-infection (*Ojajarvi, 1991*). This author is responsible for a series of field and laboratory trials conducted over fifteen years, influenced by the harsh weather conditions in Finland where skin is easily chapped. In the original trials *Ojajarvi et al, (1977)* reported "disinfection failures" related to wounding from excessive handwashing and suggested that in units where decontamination frequency was high (up to one hundred times a shift) more acceptable alternatives to traditional agents were required. Damage results from increased evaporation of water from underlying tissues via the stratum corneum, which becomes thinner as desquamation increases. Discomfort and observable damage could be demonstrated in healthy volunteers with skin in formerly good condition when a regular regime of handwashing with many of the agents commonly employed in hospitals was instituted (*Larson, Leyden and McGinley et al, 1986*). *Maki (1986)*, in an extensive review of the literature, has therefore concluded that over a certain threshold, which he appears to define arbitrarily as more than forty decontaminations per eight hour shift, increasing handwashing frequency with traditional agents may do harm rather than good. This author also calls for alternatives to traditional agents. The value of handrubs to fulfil this role is discussed in a later section.

Those who argue in favour of medicated agents for routine use must remember that no substance will remove all bacteria present (*Lilly, Lowbury and Wilkins, 1979*), while poor technique will leave areas heavily contaminated regardless of the agent employed. The most effective agent may depend on the manner in which the bacteria are carried.

An early study by *Lilly and Lowbury (1978)* indicated that although alcohol and chlorhexidine removed resident bacteria more effectively, soap and water satisfactorily removed transients which, as indicated above, is the aim of ward decontamination. Over-use of medicated agents may produce a sense of false security and could eventually lead to resistance, although this has not yet occurred (*Banquero, Patron, Canton et al, 1991*).

The findings of *Lilly and Lowbury (op cit)* may be considered in conjunction with another early study by *Sprunt, Redman and Leidy (1973)*. Field studies on a neonatal unit in which staff were advised to adhere to their usual practice revealed that a quick, perfunctory handwash with soap and water followed by brisk drying with a paper towel was sufficient to remove most transient bacteria. Medicated agents offered no special advantage, probably because staff did not wash long enough for them to exert bactericidal effect, a finding supported by *Ojajarvi (1979)*. It has led to the suggestion that outside designated high risk areas, soap and water are sufficient for most nursing procedures (*Davies, 1982; Maurer, 1985*) providing that soap is in liquid form, as bar soap is able to support the growth of Gram negative bacteria (*Jarvis et al, 1979*). Dispensers must be designed to prevent contamination of the delivery system when they are replenished (*Graf et al, 1988*). Nearly twenty years ago *Steere and Mallison (1975)* reported that policies concerned with choice of hand decontaminating agent vary between hospitals, a situation which is probably unchanged.

More fieldwork is needed to establish how clinical nurses operationalise the instructions given to them by infection control experts, especially as there is evidence that good practice may be impeded by poor facilities, including lack of suitable agents (*McLane, Chenelly and Sylvestrak, 1983; Gidley, 1987*). Relatively few studies have been conducted on general wards or to determine those occasions, outside high risk areas, when the expense of medicated agents might be justified. This would appear worthwhile as there is evidence that Gram negative bacteria can form part of the normal hand flora not only in high risk areas, but on wards (*Bruun and Solberg, 1973; Larson, 1981*). Outbreaks are by no means confined to units for the critically ill (*Casewell et al, 1977; Curie et al, 1978; Swiatlo et al, 1987*). The work of *Sanderson and Weissler (1992)* identifying ward nursing procedures which result in contamination is a step in this direction.

**Frequency of Hand Decontamination**

Of the five aspects of hand decontamination performance suggested by *Larson and Lusk (1985)* frequency has been examined most often during fieldwork, perhaps because it is the most easily observed. Comparisons are often made with CDC guidelines, which stipulate that hands should be decontaminated at least ten times during an eight hour nursing shift (*Garner and Simons,1986*). In the UK no centrally issued guidelines are available, but neither is there evidence that advice from CDC offers a substitute, as it appears to have been selected arbitrarily, without substantiating research evidence (*Glenister, 1991; Personal Communication*).

Transfer of these guidelines to the UK may be unwise as alcoholic handrubs incorporating chlorhexidine, known to have cumulative effect with repeated application, are used widely throughout Britain and the rest of Europe, but seem less popular in the USA (*Larson, Eke and Laughon, 1986*). This has implications for judging adequacy not only of frequency but duration and possibly appropriateness of timing. However, CDC guidelines have been adopted outside the USA: for example by *Graham (1990)* in Australia.

One of the earliest studies, conducted by *Albert and Condie (1981)* documented frequency of handwashing in two intensive care units over ten prolonged periods. The combined results from nurses, paramedics and doctors showed that decontamination followed 42% patient contacts. Their criterion for "contact" was strict, as it involved minimal touching (e.g. recording vital signs) but may be justified as *Phillips and Casewell (1977)* demonstrated that even this brief contact can result in transfer of $10^3$ CFU to hands. This may be sufficient to result in infection in a very debilitated patient.

Although the study by *Albert and Condie (op cit)* is not described in great detail in the published article, it appears to have captured the imagination of subsequent writers, for it is still widely quoted. The results of other studies are not easy to compare, for as Table 3.1 shows, they were undertaken in a variety of clinical settings and there is lack of uniformity in the presentation of results: interpretation is particularly difficult when length of the nursing shift is not specified.

**TABLE 3.1 Frequency of Hand Decontamination: results of observational studies**

| AUTHOR | CLINICAL SETTING | FREQUENCY |
|---|---|---|
| Ojajarvi et al 1977 | Burns unit | up to x 100 per shift |
| Taylor 1978 | General wards | 56% dirty activities are followed by handwashing |
| Ojajarvi 1981 | General wards | 11 - x 24 per shift |
| | Neonatal unit | x 44 per shift |
| Broughall, Marshman and Jackson 1984 | General wards | x 5 - x 10 per shift |
| Larson, McGinley and Grove 1986 | Oncology unit | x 8 per shift |
| Mayer et al 1986 | ITU | 63%, with increase following intervention |
| Leonard 1987 | Neonatal unit | 25.6 per shift Range 1-135 |
| Williams and Buckles 1988 | General wards | x 5 - x 7 per shift |
| Conly et al 1989 | ITU | 29% 60% after intervention |
| Graham 1990 | ITU | 32% 45% after intervention |
| Larson, McGinley Foglia et al 1992 | Paediatric unit, Lima, Peru | 29.2% after patient contact |

The circumstances under which data were collected are also known to have varied. *Albert and Condie* collected data during morning rounds when patient contacts would be highest, while in the most recent study by *Doebbeling et al (1992)*, some data collection was performed at night.

In two studies (*Broughall et al, 1984; Williams and Buckles, 1988)* frequency was determined by electronic monitors attached to soap dispensers, shown in trials to have 95% accuracy. In other studies documentation was by direct observation and accuracy could have been impaired especially in studies such as that by *Albert and Condie* when data collection occurred continuously over long periods. No mention is made in the published article of problems observing when bedside curtains were drawn, observer fatigue or how inter-rater reliability was assessed. *Linden (1990)* commented on observer fatigue during data collection in ITU, but apparently succeeded in documenting all nursing activities over four hours for four nurses simultaneously without acknowledged loss of data. The results of this study cannot be meaningfully compared to those concerned with straightforward documentation of frequency because the author was primarily concerned with whether decontamination followed glove use.

Reading these studies, conducted chiefly by medical microbiologists or infection control nurses may be seen as a depressing experience, not only because of their negative findings, but also because of authors' tendency to condemn the actions of clinical staff without acknowledging the pressures which they might be under. This is all the more reprehensible where the purpose of the research was not disclosed or staff were misled (see page 76), especially as so little attention is given to methodological flaws.

This patronising attitude is evident in a recent review by *Wenzel and Pfaller (1991)*, which contains numerous facetious suggestions for increasing compliance such as T-shirts bearing slogans with messages to promote handwashing. However, one positive conclusion emerges for nursing: handwashing frequency is generally greater for nurses than other personnel, including doctors (*Larson, MGinley and Grove, 1986: Kaplan and McGucklin, 1986; Graham, 1990*).

**Appropriateness of Hand Decontamination**

Over the years it has become apparent that a wide range of objects in the clinical environment may be contaminated with micro-organisms, such as baths (*Boycott, 1956*), washbowls (*Greaves, 1985*), hoists (*Murdoch, 1990*) and bedpans (*Block, Baron, Bogokowski et al, 1990*). Having handled such items the nurse could transfer bacteria to the next patient she touches. Evidence from Chapter One indicates that from time to time a particular unforeseen train of events can result in an outbreak, even though the same pieces of equipment are only rarely implicated. It does not, therefore, seem unreasonable to consider hand decontamination appropriate after these items have been handled.

Moving from one patient to another in rapid succession without intervening decontamination may result in colonisation. The role of close, continuous patient contact in establishing nasal colonisation of staff with Staph. aureus has been commented on by *Cookson et al (1985)* during an outbreak. Brief contact under non-epidemic situations may also result in bacterial transfer.

*Glenister (1987)* demonstrated in laboratory and field situations that hands can become contaminated when emptying catheter bags even though they do not show visible signs of contamination, while a field trial by *Overton (1988)* provided evidence of bacterial transfer via finger-tips during simulated bedmaking experiments. This confirms that routine activities such as handling used, though not necessarily soiled, bedclothes should be regarded as dirty and followed by decontamination (*Litsky, 1971*). These descriptive studies and simulations provide evidence of the many situations when decontamination could be considered appropriate, but a degree of clinical judgement may be necessary given the infrequency with which decontaminations are performed and the impracticality of washing hands after every contact in a busy ward.

Some authors (*Steere and Mallison, 1975; Ojajarvi, 1979*) acknowledge that it may be difficult to differentiate between "clean" and "dirty" procedures absolutely, suggesting that this may vary with the situation and may therefore require a degree of clinical judgement. Research instruments to assess appropriateness have been developed, but are associated with a number of difficulties.

A scheme of categorising nursing activities as clean or dirty, the Fulkerson scale, was developed for CDC by *Fox, Langer and Robin (1974)* (see Appendix One). This depends on documenting all successive nursing activities as they occur, to judge which would result in contamination and should be followed by handwashing. Decontamination would obviously be necessary whenever the nurse followed a dirty activity by one that was relatively clean, as well as before aseptic techniques.

All activities must therefore be ranked and, as this is in accordance with detailed predetermined criteria, the process appears unwieldy as well as potentially unreliable if lack of consensus between observers occurs. The scale has been used by *Taylor (1978)* who acknowledged that the system of classification might be arbitrary, but retained it so that results could be compared to studies from the U.S.A. This author established during one hundred and twenty-nine observations of handwashing that nurses failed to distinguish between clean and dirty activities, attributing this to their apparent belief that, unless soiled, hands cannot transmit infection, although her study design, consisting of non-participant observation, could not take into account the attitudes she suggested to have given rise to the behaviour she witnessed. *Sedgwick (1984)*, who was able to employ Fulkerson's scale in modified form, concluded that handwashing followed obviously dirty tasks, but was otherwise haphazard, supporting *Taylor's* data.

*Larson and Lusk (1985)* attempted to validate Fulkerson's scale on the suggestions of expert infection control of nurses asked to comment on those occasions when hand decontamination should be mandatory. They suggested considerable change (see Chapter Five). However, the most practical method of delineating between clean and dirty activities appears to be that of *Broughall et al (1984)*, drawn from general knowledge of infection control and the commonsense belief that after handling bedpans, urinals etc. hands should be regarded as potentially more heavily contaminated than when handing out meals or recording vital signs. Results corroborate those of *Taylor*: failure of nurses to distinguish between clean and dirty situations.

Further work on appropriateness would be welcomed by clinicians: *Merchant's (1988)* interview study with twenty-one qualified nurses examining performance of the aseptic dressing procedure established that subjects were more concerned with frequency and appropriateness than with technique. Appropriateness may be dependent on duration, the agent employed or an interaction between the two.

**Duration**

A number of authors attempt to link duration to appropriateness on the basis that following obviously dirty tasks hands would naturally be washed longer than after brief patient contacts. Results are not conclusive. *Taylor (1978)* as already noted, found lack of discrimination between clean and dirty tasks, a finding shared by *Quaraishi, McGucklin and Blais (1984)* who report an overall duration of 8.62 seconds. In the study by *Broughall et al (1984)* duration was on average 10.8 seconds following clean activities and 14.4 seconds following dirty ones, a result that did not reach statistical significance. *Graham (1990)* found that staff decontaminated significantly longer following "prolonged patient contact" ($p$ <0.01) but the mean for nurses was shorter (8.8 seconds) than for other staff, although nurses decontaminated more frequently than doctors. In many field studies there is also considerable range: from 2-65 seconds with an average of 9.25 seconds (*Fox et al, 1974*), 3-45 seconds (*Graham, 1990*), 5-120 seconds, median 12 seconds (*Taylor, 1978*). However, optimal duration may be determined by agent as well as by degree of contamination, a factor controlled in a laboratory study by *Kjolen and Andersen (1992)*.

They established that when hands were heavily contaminated ($10^4$ C.F.U. per finger) with Enterococcus faecalis, Staph.aureus, E. coli and Enterobacter cloacae immersion in alcoholic chlorhexidine was necessary for 20 seconds in order to remove them effectively. Ethanol, isopropanol and soap were much less effective, even when applied over this time period. These results suggest that the CDC recommendation of 10 seconds duration may not be adequate for nurses routinely providing care for incontinent patients or handling equipment such as stoma bags, although in most of the above field studies average decontamination only just reached or fell short of ten seconds.

### Technique

In most studies authors have attempted to rate only a few of the components of hand decontamination listed by *Larson and Lusk (1985)*, perhaps because such close and detailed observation is time consuming and difficult to organise. Performance of technique has been investigated least of all. In an adjunct to one of the smaller scale studies, *Taylor (1978)* persuaded nurses to perform routine decontamination with eyes shut. A dye was used, showing uncontacted areas: fingertips, thumbs, and a strip along the palm, especially on the dominant hand.

A tool to assess quality of technique, Feldman's criteria, has been available since 1969 (see Appendix One). The manner in which this was originally developed is hard to establish, although it is frequently quoted. Technique is judged according to a number of criteria: whether soap bubbles appear, avoidance of splashing, evidence of friction, surfaces covered, position of hands (whether water is allowed to recontaminate), rinsing and drying.

Again, Feldman's criteria have been used by a number of British authors (*Sedgwick, 1984; Gidley, 1987*) without comment on the success of implementation. This is surprising in view of its complexity: more recently *Linden (1991)* found it possible to determine only which hand surfaces had been decontaminated and was forced to abandon the other variables after pilot work. In its original form, the instrument was not weighted because each of the seven criteria were judged equally important. *Larson and Lusk (1985)* validated the scale on the basis of two hundred and fifty-five questionnaires distributed to hospital clinical and laboratory staff, with a response rate of 51.4%. Respondents argued in favour of simplification of the scale (although it still appears complex for use in the field) and suggested that some items (soap, friction and surfaces) should be more heavily weighted than others in view of their greater clinical significance. The scale was then found to be a valid and reliable measure by the authors, although they sidestep the issue of Hawthorn Effect by arguing that handwashing technique is a learned behaviour and therefore not possible to improve deliberately. In the new form, Feldman's criteria were used to document technique as part of a field trial lasting over two months in an oncology unit (*Larson, McGinley and Grove, 1986*). As in the study by *Taylor (1978)* and *Sedgwick (1984)*, technique varied considerably between different members of staff, but was remarkably constant for individuals.

The manner in which the seven criteria were originally selected is unknown. This is not satisfactory, as the inclusion of the items is not supported by the literature in five cases (see Chapter Five). There is no evidence to suggest that the appearance of bubbles or rinsing are advantageous, while the value of friction is apparently inferred from the study by *Sprunt et al (1973)*.

Splashing may disseminate bacteria, but in most units sinks should be sufficiently far from beds to prevent this (*Brown and Baublis, 1977*). Contaminated water trickling over hands may recontaminate them, but this has never been explored and would be a difficult problem to tackle, as handwashing will never remove all bacteria and those remaining might persist because duration or choice of agent were inappropriate. The validity of Feldman's criteria in any form may therefore appear suspect, with the exception of thoroughness and drying.

## Drying

The inclusion of drying as an important component of handwashing technique appears justified from the results of a series of laboratory simulations showing that bacterial transfer occurs more readily between wet than dry surfaces *Marples and Towers, 1978*). In the original laboratory model a non-pathogenic organism, Staph. saprophyticus, was employed, but *Mackintosh and Hoffman (1984)*, building on this work, found that contact transfer could occur in the same manner from contaminated hands when many of the genera responsible for HAI were tested, although survival times varied. Transfer of bacteria more readily via moist than dry hands has been documented in the clinical situation (*Ojajarvi, 1979*). A recent study by *Ansari, Sattar, Springthorpe et al (1991)* suggests that method of drying may assume greater importance when relatively less effective hand decontaminating agents are employed. Using E. coli and Rotavirus as the test organisms, these authors found that paper towels could remove more of the organisms persisting after soap and water had been used than linen.

This work is of potential importance because medicated agents are not always available on general wards, where drying might therefore contribute significantly to effectiveness of the handwashing process. Occasionally other hand drying methods are advocated, so their efficacy will be reviewed here.

The most usual alternative to paper towels is the hot air drier. There is some evidence, reviewed by *Blackmore (1987)* that these may contaminate hands through re-circulation of bacteria-laden air currents as well as being impractical because thorough drying would take longer. However, according to *Meers and Leong (1989)* driers are bacteriologically safe, although results may have been influenced by the high humidity and temperature conditions in which these trials were conducted. The use of a drier obviates the need to dispose of paper towels, overcoming the danger of recontaminating hands should the receptacle be touched in the process. This appears to be a common occurrence *(Gidley, 1987). Ngeow, Ong and Tan (1989)* whose field studies support the conclusion of *Blackmore (1987)* believe amount of movement affects dispersal of bacteria from driers. In their trials dispersal occurred within a radius of three feet in a side room where levels of activity were much lower than on a busy ward.

Most hospitals do not have driers, so lack of interest in drying with paper towels is an omission from the literature. No behavioural study concerned with drying could be traced except where it was included in Feldman's criteria.

**Surfaces Decontaminated**

*Bowell (1992)*, an experienced infection control nurse, suggests that thoroughness of decontamination is related to duration, recommending thirty seconds to ensure that all surfaces are contacted with agent.

The agent itself is considered by this author to be of less significance than technique. This is supported by data from *Larson, McGinley and Grove (1986)*: there was a highly significant correlation between duration and Feldman's score for technique. However, frequency was related to technique only at the 0.05 level.

**Quantity of Agent and Technique**

If thoroughness (contact of the agent with all hand surfaces) is an important component of technique, then quantity used per decontamination episode may also be worthy of consideration. Too little agent may reduce thoroughness, while over a certain optimal amount, wastefulness will occur.

Laboratory studies by *Larson, Wilder, Eke and Laughon (1987)* suggested that staff varied in the amount of agent they would normally use and that this could influence rate of bacterial hand carriage. *Doebbeling et al (1992)* observed that significantly more chlorhexidine than alcoholic handrub was used during their intervention study and interpreted this as an indication that compliance with chlorhexidine reflected staff's greater preference for this agent. The correct interpretation, however, may be that less alcohol than other agents is used under normal working conditions.

*Ojajarvi (1991),* commenting on the very brief duration of decontamination when alcohol replaced traditional agents, remarked on its tendency to "slip through the fingers" thus reducing the number of surfaces contacted and therefore effectiveness. In cross over trials conducted on gynaecology wards alcoholic handrub reduced bacterial counts by only 60%, but this increased to almost 100% six months later when staff had been taught an effective technique. On the results of this work, *Ojajarvi* suggests that alcohol could safely replace soap during routine clinical work, a conclusion shared by *Larson, Eke and Laughon (1986)* who believe that it would be beneficial under conditions without running water. However, in the UK alcoholic rubs are recommended for use by manufacturers as an adjunct to other medicated agents rather than to replace them.

The other benefit of alcohol is its more gentle effect on skin provided that emollients are incorporated. Alcohol is effective because it reduces shedding of epithelial cells (*Meers and Yeo, 1978*). Emollients may contribute to antimicrobial effectiveness by delaying the drying time of alcohol on skin (*Larson, Eke and Wilder, 1987*).

These studies with alcoholic handrubs illustrate the inseparable nature of choice of agent, duration and technique.

Authors reporting on stability of technique use it as evidence that observation during routine clinical work does not alter behaviour via the Hawthorn Effect, considered below.

## The Effect of Observation on Normal Behaviour

Laboratory studies of hand decontamination can be criticised on the grounds that no simulation, no matter how carefully planned, can provide an adequate substitute for normal behaviour in the clinical setting. Field studies, however, are open to the Hawthorn Effect, described by *Simon (1969)* and *Raven and Rubin (1976)*. Where detailed observation has taken place it seems likely that staff may have altered behaviour, possibly increasing frequency and duration of hand decontamination. Some researchers attempted to avoid this by omitting to inform subjects of the purpose of the study (*Fox et al, 1974*) or misleading them (*Albert and Condie, 1981*), although this may not always have been successful: subjects observed by *Graham (1990)* were thought to have guessed why they were watched. Other authors have documented such poor practice that the Hawthorn Effect, at least for some individuals, seems to have been minimal. Into this category fall the nurses in *Gidley's* study (1987) who omitted to use any agent and the nurse observed by *Sedgwick (1984)* to complete an entire shift without one decontamination. Nurses under surveillance during a staphylococcal outbreak (MRSA) continued to touch their faces and mucous membranes although they knew why they were watched (*Cookson et al, 1985*).

Possibly the effect of observer on routine behaviour is unsystematic and complex, but it deserves greater attention than is usually given in published articles because if marked, could influence ~~results. Numerous research teams have been content to report~~ that Hawthorn Effect was minimal because staff assured them of this (*Larson, McGinley and Grove, 1986*), or do not report how it was assessed (*Leonard, 1986; Doebbeling et al, 1992*).

Evidence from *Cookson et al (1985)* suggests that some behaviour is too involuntary to change, perhaps because it is subconscious. This has implications for altering behaviour through educational campaigns.

**Summary of Hand Decontamination Research Studies**

Most research in this sphere has been concerned with testing the efficacy of medicated agents, although in many hospitals their use may be restricted to designated high risk areas. There is evidence that decontamination is performed relatively infrequently and often very briefly, though with considerable variation between different individuals. Speed of decontamination may prevent bactericides exerting effect even if they are used. Technique has less seldom been examined, probably because such close observation is obtrusive and disruptive under field conditions. Few behavioural studies are reported in much detail and it is likely that at least some, possibly most,are methodologically flawed, but this has not prevented authors concluding that poor practice is the norm and attempting to establish reasons.

**Exploring Reasons for Poor Hand Decontamination**

According to *Nystrom (1992)*, infection control experts have a key role to play in quality control of patient care. The importance of HAI has been recognised during the development of quality assurance programmes in view of the clear relevance to patient safety and tangible economic return coupled with the relatively measurable nature of infection rates (*Shaw, 1986*). However, some authors go only as far as implementing standards without apparent attempts to examine infection rates (*Carter, 1991*). Providing advice does not guarantee that it will be acted upon.

*Cadwallader (1989)*, disappointed at lack of response following the implementation of an updated infection control policy, was forced to conclude that the expertise of microbiologists and infection control nurses will remain of limited value in the absence of commitment from clinical nurses. Lack of motivation and accountability for HAI on an individual basis may be contributory factors according to *Bartzokas and Slade (1991)*, a microbiologist and social psychologist currently seeking to assess, then improve motivation to comply with infection prevention protocols. This is a complex issue. Questionnaire studies indicate that nurses and doctors are aware of the need to decontaminate hands to reduce HAI, but are reluctant to decontaminate more often, chiefly because this would result in sore, dry hands (*Larson and Killien, 1982; Zimacoff et al, 1992*). These surveys, though extensive, can be criticised on the grounds that staff assessed their own handwashing frequency, which may result in over-estimation, a phenomenon reported by *Broughall et al (1984)* and *Williams and Buckles (1988)*. Direct observation was not performed. In view of this, the suggestion by *Zimacoff et al (op cit)*that females decontaminate more often than males regardless of profession remains open to question.

A study in the Far East identified tactics employed by infection control nurses to improve compliance by asking clinical nurses to state approaches which they found most helpful (*Seto, Ching, Chu et al, 1990*). Specialist and ward nurses found trust based on professional respect mutually more beneficial than coercion or threats.

In the UK infection control nurses do not usually occupy line managerial positions within the nursing hierarchy and it is difficult to imagine coercion having much impact in UK hospitals where the value of a reasoned, research-based approach to all aspects of patient care is advocated (*Bircumshaw, 1990*). *Wenzel and Pfaller (1991)* however, in a light-hearted vein suggest that there may be a place for the use of social and peer pressure in improving handwashing frequency providing that facilities are available and acceptable. The public is increasingly conscious of what constitutes "good quality" care, especially in the USA where these authors work and this, coupled with growing public anxiety about infection in the wake of HIV, might also step up pressure. Changes within the NHS and the introduction of a more consumer-oriented approach may well encourage patients and families to become aware of standards in the UK. Limited evidence suggests that good role models may promote frequency of hand decontamination in particular circumstances (*Larson, 1983*) while the introduction of infection control liaison nurses, clinical nurses who have received some additional training in infection control, may enhance awareness of risks among colleagues (*Ching and Seto, 1990*). These changes, to be effective, require co-operation from ward managers and staff before they can be introduced. Evidence from a different body of literature strongly suggests that hospital morale and ward climate influence many areas of nursing practice.

### Hospital Morale and Ward Atmosphere

Good standards are likely to be set on wards where morale is high. Work by *Revans (1964)* is frequently quoted to link quality of care to morale. According to *Revans (op cit)* hospitals are complex organisations demonstrating distinct characteristics able to affect the morale of staff and patients.

In hospitals where level of morale was high there was lower turnover of nursing staff, lower sick rates and patients were discharged more quickly. Wards in such hospitals were reported as having a better atmosphere than those in hospitals with high nursing turnover, high sickness rates and low rates of patient discharge. Good communication was a feature of institutions where morale was high.

A review of the nursing literature up to 1979 indicated that nurses accepted the phenomenon of "ward atmosphere", although apart from *Revan's (1964)* classic study little attempt had been made to conceptualise or quantify it (*Orton, 1981*). This author undertook a questionnaire study among ward sisters which revealed that the sister's positive attitude toward learners provided a sound indicator of good ward atmosphere. Ward organisation was also considered important in the results drawn from this study, particularly leadership style of the sister and the quality of her relationships with staff. Questionnaires distributed to three hundred and twenty-five student nurses on forty-four wards indicated that they perceived favourable ward climates to exist where the sister was able to recognise their needs and was committed to teaching. Teamwork on these wards was good, with evidence of effective communication: the emotional needs of patients as well as learners were met. *Orton* thus assumed that good ward climate must also benefit patients. In a later observational study *Fretwell, (1982)* provided corroborating evidence that learning environment was well rated by students on wards where there was a democratic leadership style. *Revan's* original work identified anxiety and stress as deleterious factors not only on patient care, but on student learning, a view that has since been confirmed (*Birch, 1979*).

These threads were drawn together by *Smith (1987)* who attempted to link quality of nursing to the quality of the ward as a learning environment for student nurses. From her multi-method approach involving qualitative and quantitative measures she concluded that nurses preferred technical aspects of their work and valued it as good learning experience, although they recognised the importance of emotional care to patients. The sister's management style, as in earlier studies, was judged influential in the creation of learning environment. Patients judged quality of nursing on the emotional style in which it was given.

Although these studies do not link ward climate and prevention of infection directly, they are relevant as it is reasonable to suppose that on a ward where a good atmosphere prevails, with commitment to teaching, permanent staff would demonstrate professionalism in all aspects of the care they deliver, including those technical aspects valued by students as valuable learning material. Opportunities to develop HAI and to prevent it are higher in wards where patients undergo many technical procedures. Motivation of staff and learners on wards with good atmosphere would presumably be high.

**The Relationship of Resources to Hand Decontamination**

Poor motivation and lack of resources may be related issues. Observing that nurses tended to wash hands more often at a sink positioned near the nurses' station, *Broughall et al (1984)* proposed that more sinks placed nearer to patient care areas might increase compliance.

Evidence is mixed. A study by *Kaplan and McGucklin (1986)* suggested improved compliance on a unit with more sinks, but evidence from *Preston et al (1981)*, documenting handwashing compliance and infection rates before and after the upgrading of an ITU with the provision of additional sinks, did not. *Larson, McGinley, Foglia et al (1992)* describing handwashing practices and the nature of hand flora among sixty-two paediatric staff throughout one teaching hospital identified variations in practice and carriage rate between wards which could have resulted from the different facilities provided, but the design of their study does not permit definite conclusions. This work was undertaken in a Third World country, where behaviour and facilities were not comparable to the situation in the UK or USA.

Although provision of facilities appears potentially important, other variables may contribute. These include their acceptability and levels of ward activity.

**Acceptability of Facilities: sore, dry hands**

Even when facilities are good, hand washing may be avoided because staff have developed sore, dry skin, itself undesirable as it increases bacterial colonisation (*Ojajarvi et al, 1977*), especially by Gram negative strains (*Larson, 1984*). Hospital staff are well aware of the risk of soreness. A questionnaire study by *Newsom, Rowland and Wells (1988)* established that surgeons' choice of hand scrub agent depended mainly on skin tolerance and other more trivial factors such as appearance and smell, findings substantiated by *Scott, Barnes, Lister et al (1991)* for hand decontaminants.

In the ward situation nurses as well as doctors report avoidance of harsh agents *(Larson and Killien, 1982; Zimacoff et al, 1992).* Chlorhexidine is regarded as particularly damaging (*Webster, 1992*). These problems are not insurmountable as manufacturers are now paying increased attention to product acceptability. Recent trials have demonstrated that cleansing with disposable alcoholic wipes incorporating emollients (*Butz, Laughon, Galette et al, 1990*), antimicrobial gel (*Newman and Seitz, 1990*) or an emulsion to replace soap and water (*Kolari, Ojajarvi, Lauhuranta et al, 1989*) can reduce cracking, drying and erythema while effectively removing transient flora. Indeed *Ojajarvi (1991)* advocates that in Finland where harsh weather conditions contribute to skin soreness, hospital staff should use agents kinder to hands than soap during winter. The effect of cold weather on skin condition when combined with frequent handwashing has been documented by other authors (*Larson, McGinley and Grove, 1986*). Much remains to be learned from the cosmetic industry in the production of skin creams and emollients (*Kobayshi, 1991*) although care must be taken over methods of dispensing as a poor delivery system can lead to contamination of hand cream (*Morse and Schonbeck, 1968*).

**Levels of Ward Activity and Decontamination**

Related to availability and acceptability of resources is the issue of being too busy to use them. Throughout the literature there are suggestions that at busy times hand hygiene is more likely to break down (*Lowbury, Thom, Lilly et al, 1970; Noone et al, 1983*) although *Taylor (1978)* could not relate levels of ward activity to handwashing. Her method of assessing the degree of activity is not, however, explained in the published article.

*Haley and Bregman (1982)* employing a multivariate statistical model, correlated under-staffing and overcrowding in a neonatal nursery to cross infection culminating in a staphylococcal outbreak. In contrast to the study by *Broughall et al (1984)*, these nurses and doctors recognised and were concerned about defects in hand hygiene when busy. The extensive and well controlled study by *Doebelling et al (1992)* incorporated a measure of nursing workload to control variables which might affect handwashing compliance and rates of HAI when different hand decontamination protocols were tested in the clinical situation. The measure, which revealed no fluctuation in workload throughout the trial period, was not designed for the study but thought to be valid because it provided a measure of nurse-patient interaction. Every time a patient is touched there is potential for bacterial transfer.

**Knowledge, Skills and Hand Decontamination**

Inevitably poor hand hygiene has been attributed to lack of knowledge, a view endorsed by *Sedgwick (1984)*, who points out that apart from teaching in relation to aseptic technique, nurses receive little guidance. Possibly this is because handwashing is regarding as a "social" rather than a "technical" or "professional" activity. *Feldman (1969)* remarked on the lack of impact of theoretical instruction on aseptic technique, which is still known to be performed poorly (*Mclane et al, 1983; Merchant, 1988; Klapes, Greene and Langholz, 1987; Kelso, 1989*), although it is regarded as a vital nursing skill by educationalists (*Sweeney, Hedstrom, O'Malley, 1982*). The associated technique of hand decontamination is not mentioned by these authors, but it was ranked among the three most vital skills in a questionnaire study by *Kieffer (1984)* in which fifty-four nurse teachers were invited to state which of 154 skills they considered mandatory for newly qualified nurses.

Hand decontamination meets the criteria of a psychomotor skill defined by *De Tornyay and Thompson (1987)*:

> "A manipulative skill requiring the learner to perceive and co-ordinate sensory stimuli and to complete purposeful movements" (page 60)

It should therefore be open to improvement through programmed instruction. This is possible on the evidence of *Ojajarvi (1991)*, but in the UK a campaign to improve hand decontamination compliance by teaching the skill through video and poster demonstrations met with limited success (*Williams and Buckles, 1988*), a failure attributed to poor motivation. Neither of these authors were educationalists and they appear to have relied upon rather passive, non-participatory educational methods, despite the fact that opportunity to practise skills with feedback is known to be appreciated (*Olson, 1983; McAdams, Rankin, Love et al, 1989*). Input from tutorial staff might have been beneficial, while this group, in turn, might profit by collaboration with infection control experts, as they feel poorly prepared to teach microbiology and are unsure of what should be included (*Akinsanya, 1982; Courtnay, 1991*). Sadly the teaching of psychomotor skills by nurse teachers appears to be falling from favour (*Chandler, 1991*).

Infection control is frequently included in orientation programmes and study days for newly qualified staff. *Matthews (1991)* describing attendance at an infection control liaison course, found participation rewarding, particularly as it enabled him to develop and introduce an educational campaign into his own clinical area. His colleagues were aware of the need for good standards of infection control, but gaps in knowledge were identified, particularly among newly qualified staff.

The need for informal updates became apparent, particularly in relation to "basic" microbiology, catheter care, isolation procedures and MRSA. Input was ward-based as staff could not always be spared to attend formal study days.

The interest and commitment of clinical staff to infection control is further exemplified by *Gill and Slater (1991)* who reviewed the literature concerned with protective clothing, investigated local practices and introduced a new policy to patients and staff throughout their hospital. Perhaps the influential factor in these studies was the opportunity for clinical staff to take initiative, identify and fulfil their own educational needs rather than having these imposed on them by infection control experts, whose failure to improve handwashing compliance through intervention has become legendary.

**Intervention Studies**

In view of the link between poor compliance and dislike of harsh agents, a number of authors have attempted to increase decontamination frequency by introducing emollient handrubs. Success is variable. *Graham (1990)* increased compliance 13% for a short period only, while *Conly et al (1989)* found this approach ineffective. In a later trial presented within the same paper this team was able to increase frequency to a significantly higher level by providing feedback to staff on their performance the previous day. This corroborates the results of *Mayer et al (1986)* who also provided feedback in a similar setting (ITU).

Possibly this increased sense of accountability, which *Bartzokas and Slade (1991)* believe nurses and doctors lack. However, the success of these campaigns was short-lived, probably because staff turnover was high and there was continual need for updating, as indicated by *Matthews (1991)*.

*Williams and Buckles (1988)* found that an educational campaign comprising exposure to videos, posters and pamphlets temporarily increased knowledge compared to a control hospital lacking intervention, but that without input concerning handwashing technique, frequency remained unaltered.

*Becker et al (1990)* reporting lack of compliance with sharps disposal policy, attribute failure of a continuing education campaign to lack of specificity: teaching was the same for everyone regardless of clinical setting or length of experience. Like *Bartzokas and Slade (op cit)*, this team consisted of social psychologists and microbiologists.

Both teams concur that before improvements in motivation reach clinical practice, efforts are necessary to establish the knowledge and beliefs of individual members of staff so that intervention can be tailored to particular need. There is some indication that ideas about infection are vague and have little to do with knowledge or even rational consideration. An ethnographic study by *Roth (1957)* conducted in a sanatorium demonstrated illogical and sometimes bizarre measures to control tuberculosis. However, this study was undertaken long ago, under special circumstances, so it may not be possible to extrapolate findings to general wards.

Success appears greatest when clinical staff themselves are prompted to conduct their own investigations and improve local practice, as shown by *Matthews (1991)* and *Gill and Slater (1991)*. The second study also serves to illustrate nurses' concern with the role of protective clothing in the prevention of HAI. This chapter concludes by reviewing this literature.

**The Role of Protective Clothing in the Prevention of HAI**

Studies reviewed in Chapter Two considered the epidemiology of staphylococci in the ward environment, including ITU, showing hand transmission to be the major route of dissemination. In contrast, airborne spread is problematic in special environments such as theatre (*Lidwell, Lowbury, Whyte et al, 1983*). This literature will be reviewed briefly here, as it throws some light on nurses' preoccupation with the use of protective clothing rather than hand decontamination in containing hospital pathogens.

The role of gowns, aprons, masks, hair and foot protection in wards and special hospital environments is discussed. Finally, a consideration of glove use leads into Chapter Four.

**The Role of Gowns and Aprons in the Prevention of HAI**

There is ample evidence that within particular high risk settings, the use of expensive, specially developed protective clothing is justified, owing to the source of micro-organisms, which is different to that for patients on general wards, and the vulnerable nature of the client group.

An investigation into sources of bacterial contamination during hip and knee replacement under conventional and laminar flow conditions in theatre by *Whyte, Hodgson and Tinkler (1982)* demonstrated that 98% micro-organisms in wounds came from air directly or from air via other surfaces (hands, instruments). Similarly, in burns units where patients have lost large areas of skin, the body's chief defence against infection, airborne spread is an established risk (*Hambraeuss, 1973*). This author established from a series of trials simulating routine nursing activities that gowns prevent transfer of staphylococci to patients via nurses' uniforms at least fourfold and up to tenfold. In the original experiments gowns were made of cotton, but closely fitting garments with special filters have produced superior protection (*Hambraeuss and Ransjo, 1977*). Similarly, polyester garments in theatre appear safer where risks are known to be high (*Whyte, Hamblen, Kelly et al, 1990; Scheibel et al, 1991*).

A review by *Mackintosh (1982)* confirms that in high risk areas research concerning protective clothing has now become highly specialised, resulting in sophisticated garments justified because patients are particularly vulnerable, but in wards hazards of airborne spread, including over short distances from skin scales on clothes, appear to have been over-estimated. Possibly this dates from the 1960's, when *Speers, Shooter and Gaya (1969)*, sampling nurses' uniforms by a "sweep plate" method to simulate likely opportunities for contamination thought to occur during ward activity, established heavy contamination, especially when septic wounds had been dressed. Isolation of staphylococci from dresses beneath the apron implied that bacteria could pass through cotton weave, leading the authors to recommend plastic aprons.

They hypothesised that friction between aprons and the edge of a bed could release "bursts" of airborne staphylococci near a wound exposed during dressing changes. *Babb, Davies and Ayliffe (1983)* have since demonstrated that even when clothes are heavily contaminated by staphylococci released in large numbers from heavily discharging wounds, this does not appear to represent a significant threat to other patients on the same ward. In these experiments plastic aprons carried fewer bacteria than cotton ones. The authors suggested that this was because the cold, slippery plastic surface encouraged bacteria to dry. Today there appears little justification for the use of cotton gowns: a prospective trial by *Haque and Chagla (1989)* indicated that use by medical and paramedical staff had no effect on rates of HAI in a neonatal unit probably because most infections were endogenous. They are not necessary for individuals who will have no patient contact, although it is sometimes recommended that all visitors to ITU should wear aprons (*Nystrom 1981*). Despite this, the decision of whether or not to replace cotton gowns with plastic aprons remains a popular topic for debate within the nursing press (*Wilson, 1990; Gill and Slater, 1991). Curran (1991),* in favour of plastic aprons, points out that they are cheap (2p each at 1991 costs) and should therefore be regarded as disposable, as manufacturers recommend, and discarded between patients or after procedures likely to result in heavy soiling.

**Masks, Hair and Foot Protection**

Similarly, the value of masks and hair covering is now being questioned, even in recognised high risk environments. A simulation experiment demonstrated that paper masks are superior to fabric ones in containing bacteria released by sneezing (*Masden and Masden, 1967*).

In recent years, with paper as the usual material, filtration efficiency has been emphasised through need to protect the patient, although the possible risk of HIV cannot be ignored in laser surgery where an aerosol plume is created by vaporisation of tissue. There is no single method of assessing mask efficiency, but tests by *Davis (1991)* suggest that even when filters are present, air and bacteria can escape round the sides of the mask. Recent questioning of the value of masks in general surgery (*Tunevall, 1991*) has occasioned comment by *Orr and Bailey (1992)* that over ten years, with an annual average of eight hundred and sixty-one operations per annum, wound infections for non-emergency procedures when masks were not worn was less than 2%. Infections recorded by these authors were believed to reflect the type of surgery performed or the patient's condition, not carriage of pathogens by theatre staff.

Hair has long been recognised as a source of staphylococci (*Summers, Lynch and Black, 1965; Noble, 1966*) but a recent study demonstrated that disposable hair covering had no effect on bacterial air counts when six volunteers were sealed in a room, unless unventilated (*Humphreys, Russell, Marshall et al, 1991*). The authors recommend that non-scrubbed staff lacking direct contact with the operation field need not wear hair covering, as effective ventilation should counteract the effects of bacterial shedding, except in high risk situations (e.g. orthopaedics).

Evidence from Chapter One suggests that under normal circumstances the floor does not usually contribute to HAI. Not surprisingly, *Meddick (1977)* could find no advantage in the use of bacterial contamination control mats positioned outside theatre doors.

Overshoes increase risks as hands may be contaminated when they are removed (*Carter, 1991*).

**Summary: The role of protective clothing in the prevention of HAI**

The combined results of these studies suggest that considerable expense could be spared if useless protective clothing was abandoned or cheaper alternatives introduced, particularly in wards. Time spent gowning could be saved and correct treatment of plastic aprons as disposable could obviate considerable discomfort to staff (*Curran, 1991*). From epidemiological studies it is apparent that in wards contact spread is most important and that although attention to hand hygiene may not always halt an outbreak (*Crossley, Landesman, Zaske, 1979*), there is evidence that it will do so when rigorously enforced (*Donowitz, 1986; Isaacs et al, 1991*).

**The Role of Gloves in the Prevention of HAI**

The use of gloves to reduce risks of HAI has been suggested by a number of authors to overcome problems when wards are particularly busy (*Lowbury et al, 1970*), when outbreaks occur (*Noone et al, 1983*) and when hands are likely to become heavily contaminated (*Kjolen and Andersen, 1992*). Their value in reducing risks to staff from parenterally spread infection has been recognised in recent years and today it has become accepted that gloves are worn for the protection of both patient and nurse. Surprisingly, in view of concern engendered by HBV and HIV, no national guidelines for the use of gloves exist in the U.K. (*Jenner, 1990*) and attitudes toward implementation vary.

*Linden (1991)* documenting favourable attitudes towards glove use in ITU, calls for a standard national policy, a view which would not be shared by *Simpson (1991)* who believes that with infection control policies generally, local guidelines are superior because they are more flexible than regulations imposed centrally. Guidelines from CDC have been available since 1987.

Initially there was some confusion within the literature concerning the need to decontaminate hands when gloves had been worn (*Lynch, Jackson, Cummings et al, 1987; Larson, 1989*), but today it is agreed that both are necessary because gloves worn for any length of time increase bacterial counts on hands through sweating (see Chapter Two) and may be damaged during use. The issue of glove use in the prevention of parenteral infection is discussed in Chapter Four.

**Summary: Chapter Three**

This chapter has explored the role of hand decontamination in the prevention of HAI. Hand decontamination emerges as an unexpectedly complex procedure consisting of numerous distinct components, all of which have been performed suboptimally in previous descriptive studies. Attempts to promote compliance have produced disappointing results long term. Several reasons for failure have been suggested, including lack of knowledge, poor facilities and low morale. These may be inter-connected and merit more detailed examination. By comparison, the use of protective clothing has a much less important role to play in the prevention of HAI in general wards, although it has stimulated more concern among clinical nurses. Gloves, worn to protect both patient and nurse, provide a degree of protection to both.

# CHAPTER FOUR

## NOSOCOMIAL PARENTERAL INFECTIONS

Health professionals may contract a number of infectious conditions from patients, including the classic communicable diseases (e.g. tuberculosis, varicella) (*Moore and Kaczmarek, 1990*), but concern centres around exposure to blood and body fluids. These place the individual at risk of numerous virus infections (*Schaechter, Medoff and Schlessinger, 1989*), but the two which have excited most concern for personal health and safety are the hepatitis B virus (HBV) and human immunodeficiency virus (HIV). This is not surprising in view of the attention they have received in the medical press (*Geddes, 1986; Goodacre, 1987; Reinecke, 1987*) and now to an increasing extent in nursing journals (see *Goodlad, 1991*). The purpose of this final chapter of the literature review is to discuss the natural history and hazards associated with HBV and HIV before considering how these may be reduced. Controversy surrounding recommended precautions and gaps in present knowledge are explored.

### Natural History of HBV and Risks to Health Care Professionals

Textbook information prepared especially for a nursing readership describes hepatitis B as an inflammatory condition affecting the liver, presenting as a mild or more serious, disabling illness (*Pritchard and David, 1989; Hart, 1990*). The incubation period is variable (4 weeks-6 months), but individuals are probably most highly infectious during the early, acute stages. Approximately 30-40% of those infected develop symptoms of acute illness, but these may be non-specific (fever, malaise). Not all become jaundiced, while others develop symptoms so mildly that the nature of the infection is unsuspected. Between 50 and 60% of individuals remain asymptomatic despite serological evidence of infection.

It appears that these are most likely to become chronic carriers, at greatest risk of developing cirrhosis and hepatocellular carcinoma (*Main, 1991*). The review by this author convincingly demonstrates that perinatal infection carries a particularly high (95%) risk of chronic liver disease, including malignancy, in middle age.

Although hepatitis B is a notifiable disease lack of specific signs and symptoms coupled with high rate of subclinical infection means that it is impossible to document prevalence accurately. Over the years epidemiologists have agreed that homosexuals, immigrants, intravenous drug abusers and those living in institutions for the mentally handicapped are at increased risk of carrying the virus (*Follet and Sleigh, 1980; Polakoff, 1986*). By implication nurses employed in these clinical settings could also be considered to be at particularly high risk, but in the U.K. this view has been refuted on the grounds that all nurses are routinely exposed to blood and body fluids. This has been used to argue the need for a comprehensive vaccination programme by the major nursing unions (*Goodlad, 1991*). Possibility of exposure during invasive procedures, particularly in ITU and emergency situations, are emphasised by nursing authors. *Gurevich (1988)* describes a number of scenarios typical in these clinical settings when urgent patient needs may preclude the use of protective clothing, including gloves. This has been verified by *Kelen et al, (1989)* who observed that compliance with universal precautions declined from 44% to 19.5% when patients were profusely bleeding. In a questionnaire follow-up it was stated that under these emergency circumstances there was insufficient time to take precautions.

HBV is transmitted primarily by the sexual route (vaginal, anal), parenterally through sharps injury or sharing infected needles, by contamination of mucous membranes and via fresh cuts and abrasions.

Infants born to mothers who developed acute HBV infection during the final trimester or who are highly infectious carriers may also develop infection (*Polakoff, 1986*). It has become apparent that health-care workers have a higher rate of HBV carriage than the general population. Outbreaks have occurred in hospitals, particularly renal units when staff as well as patients have become infected (see *Callender, White and Williams, 1982*). HBV can therefore be regarded as a nosocomial pathogen (*Janzen, Triatzis and Wagner, 1978*) and is classified as an industrial disease among health-care professionals in the U.K. (*Communicable Diseases Report, 1979*) and U.S.A. (*Kwapien, Phillips and Anderson, 1987*).

Efforts have been made by epidemiologists to determine hospital employees most at risk. *Denes et al (1978)* established that among medical staff, carriage is highest for those who have been practising for over thirty-five years and those who have conducted invasive procedures most often, implying that degree of exposure is positively correlated to risk of seroconversion. Only 31% of the two hundred and twenty subjects found seropositive in this nation-wide epidemiological survey could recall a personal history of clinical hepatitis, emphasising the tendency of seropositive infections to remain asymptomatic. Most worrying of all was the inability of many HBV-positive staff to recall specific incidents which could have resulted in infection; fifteen of the fifty-one individuals in the study by *Callender et al (1982)* were unable to remember sharps injury. It is also recognised that seroconversion can follow the most trivial skin damage, or when staff can recall no damage at all (*Pantelick, Steer and Lewis, 1981*). One epidemic occurred among laboratory staff who had apparently been placed at risk through cutting fingers on the sharp edges of registration cards (*Pattison, Boyer, Maynard et al, 1974*).

More recently nosocomial transmission of the virus has been traced in a case control study among diabetics to patients who had undergone blood sampling with an inadequately cleaned spring-loaded lancet device (*Polish, Shapiro, Bauer et al, 1992*). This study is of particular interest since victims were exposed to minute traces of blood. Generally staff rather than patients are considered at risk (*Papaevangelou, Roumelioutou-Karayannis and Contyannis, 1981*).

No treatment for hepatitis B exists, but an effective and safe vaccine has been available since the early 1980's (*Szmuness, Stevens and Harley, 1982*). Before its introduction those known to be at risk as a result of sharps injury could be effectively given passive immunity with anti-HBV immunoglobulin (*MRC and PHLS report, 1980*) but the result of randomised, blind trials indicate that vaccine is more effective in prophylaxis (*Seeff, Wright and Zimmermann, 1978; Dienstag, Werner and Polk, 1984*).

Even without prophylaxis, hepatitis B carries a low risk of mortality (*Polakoff, 1986*), but the infection is at best unpleasant and can in some cases have grave morbidity, so prevention is vital. It is now reportable under the Reporting of Injury, Diseases and Dangerous Occurrences Regulations (1986). The Royal College of Nursing strongly recommends vaccination for all members of the profession, arguing that hospital occupational health departments could be responsible for a technical breach of the Health and Safety at Work Act (1974) if it is not readily available (*Jackson, 1989*).

**Natural History of HIV**

~~The HIV virus was identified by *Gallo, Salahuddin, Popovic et al* in 1984.~~ Its emergence among the homosexual population in Los Angeles in the early 1980's has been comprehensively described by *Pratt (1988)*.

Like HBV, HIV is a major risk to intravenous drug abusers, but in recent years authors have emphasised that there is also some risk to the general population. Incubation is known to be variable and lengthy: tests to demonstrate seroconversion cannot be contemplated until three months after possible exposure to the virus. Much has been written about HIV epidemics in the popular and medical press. Like HBV, HIV is transmitted primarily via infected blood and blood products, sexual contact and perinatally. Virus particles have been identified in other body fluids but a comprehensive review of the literature could find no evidence of transmission in saliva, tears or urine (*Lifson, 1988*). Mortality from hepatitis B is approximately 1% in those infected, but far higher for HIV, although it has been long recognised that not all those exposed to the virus become infected (*Adler, 1987*); of the two agents there is circumstantial evidence that HBV is considerably more infectious *(Geberding, 1985)*. No vaccine has been developed against HIV and there is no cure at present. Zidovudine (AZT) is beneficial in reducing symptoms once they arise (*Fischl, Richman, Hanson et al, 1990*) but will not prevent them occurring (*Aboulker and Swart, 1993*). It has also been given prophylactically following exposure to blood contaminated with HIV, but its efficacy under these circumstances is difficult to evaluate because so few health workers to date have undergone seroconversion despite needle stick injury (*Meylan, Francioli, Decrey et al, 1988*).

The grave morbidity and mortality associated with HIV have resulted in careful surveillance of health-care workers exposed to risk, combining follow-up and publication of epidemiological data.

*Marcus (1988)* concluded from a national surveillance study conducted for the CDC that of 1201 individuals (751 nurses, 164 doctors and 286 paramedics) only four had seroconverted 180 days after exposure.

However, results are difficult to interpret because several known homosexuals and intravenous drug abusers were included in the sample. Three of the four who underwent seroconversion could recall needle stick injury.
According to statistical data produced by *Leentvarr-Kuijpers, Dekker, Countinho et al, (1990)*, risk of HIV infection following needle stick injury in theatre for surgeons is extremely low.

*Geberding, Bryant-Le Blanc and Nelson, (1987)* conducted a prospective cohort study designed to evaluate risk of occupational transmission of parenteral pathogens to individuals with intensive exposure to HIV patients. Seventy-five per cent of their 270 subjects had been exposed to patients with AIDS and AIDS-related conditions for at least a year and 35% sustained between them 342 accidental exposures to HIV-infected blood and body fluids. None had antibodies to HIV when recruited into the study and ten months later none had undergone seroconversion.

The results of these studies, conducted among very different groups of health-care personnel working under different conditions, indicate that risk of transmission from patients is small. Nevertheless, there is no room for complacency, for as *Goodacre (1987)* points out, no doctor (or nurse) wishes to be the first person to demonstrate that it is possible to develop AIDS easily from a patient. These results must also be interpreted with caution given the very long incubation period of HIV and the fact that none of the staff in the sample collected by *Geberding et al (1987)* had developed HBV antibodies although some of their patients must undoubtedly have been carrying the virus.

**Risks from Environmental Contamination**

Staff who work in clinical settings where there is risk of blood spillage are understandably concerned about possible exposure to infective parenteral viruses. It is generally accepted that delicate micro-organisms which depend on parenteral and sexual spread are unlikely to survive well outside the tissues, but the blood or plasma itself appears to confer a degree of protection. HBV is able to survive for up to a week in plasma and is therefore regarded as resistant under dry conditions (*Bond, Favero, Peterson et al, 1983*).

Risk of transmission probably depends on the number of virus particles present. Spillage on clean and soiled surfaces may be effectively disinfected with chemical agents *(Bond, Favero, Peterson et al, 1981; Coates and Wilson, 1989; Bloomfield and Miller, 1989)*, but other items in close patient contact handled by nurses may be less easily disinfected or risk may be ignored or not fully appreciated. *Forseter, Joline and Wormser (1990)* observed that 30% tourniquets in routine use had been contaminated with blood. Careful questioning revealed that staff would sometimes re-use items despite bloodstains. Similarly, HIV was once believed to survive for only a very short time outside the tissues, but laboratory experiments have demonstrated possible survival for days when protected with plasma and have shown that disinfectants vary in their ability to inactivate the virus. Glutaraldehyde, an expensive chemical disinfectant with marked and undesirable side-effects unless carefully handled, is superior (*Hanson, Gor, Jeffries et al, 1989*), providing solutions (2%) are freshly prepared.

**Reducing Risks of Parenteral Nosocomial Infection**

Because HBV and HIV are transmitted via infected blood and body fluids within health-care settings, it is rational that staff should be taught to reduce risks by avoiding direct contact with these substances, to cover cuts and abrasions with water-proof dressings, provided with clear instructions on the action to take in the event of sharps injury and offered HBV immunisation as well as equipment (gloves, sharps boxes) to help reduce risks. However, each of these apparently straightforward precautions has generated considerable debate and differing opinion as well as a number of practical difficulties. Even the most elementary precaution, glove use, has become surrounded by controversy because the subject is emotionally laden and confusion reigns over whether they are intended to protect the patient, professional or both.

**Glove Wearing Versus Other Precautions**

Gloves were originally introduced to protect the hands of theatre staff from contact with antiseptics which, with repeated use, could cause irritation. As early as 1960 it was observed that when staff in a renal unit wore disposable gloves the incidence of hepatitis B declined (*Mitchell, Cumming, MacLennan et al, 1983*). The use of gloves to protect staff rather than patients from infection has since escalated. *Goldmann (1991)* wryly comments upon the apparently recession-proof nature of the glove-manufacturing industry despite soaring costs at a time when other cutbacks in health spending seem inevitable.

Most advice has been directed toward surgeons and dentists because of the invasive procedures which place them at particular risk. Far less attention ~~has been given to the needs of nurses in general wards.~~

Surgeons may be exposed to blood when glove punctures occur, although these may not be apparent until the end of the procedure (*Hussain et al, 1988; Dodds, Guys, Peacock et al, 1988*). Risk estimated prospectively over a three-month period was greater towards the end of long operations, presumably because surgeons were becoming careless through tiredness; but for scrub nurses, the group who, next to surgeons, have greatest exposure to blood (*Closs and Tierney, 1990*), risk was related to handling instruments and needles regardless of the length of the procedure (*Brough et al, 1988*). These studies have resulted in surgeons publishing guidelines for safer techniques such as double or even triple gloving where significant risk is believed to exist (*Sim, 1991*), preventing fingers directly contacting tissue and minimal use of sharp instruments (*Raahave and Bremmelgaard, 1991*). There is tentative evidence that surgeons are gradually modifying practice, although most still place themselves at some risk (*Porteous, 1990*). Knowing that gloves will be examined for damage at the end of the operation may reduce the incidence of puncture, suggesting that under particular circumstances theatre staff are willing to take greater care (*Walter and Kundsin, 1969*). This does not, however, overcome the problem of splitting, which appears to be a drawback with some brands during heavy use (*Dalgleish and Malkovsky, 1988*).

The degree to which the findings of studies concerned with glove puncture during surgical and dental practice can be generalised to the nursing situation is not clear, given the different mechanical stresses in a ward. In this setting gloves are likely to be worn for shorter periods of time and different brands may be available.

*Korneiwicz, Laughton, Butz et al (1989)* tested the integrity of vinyl and latex gloves under conditions simulating ward nursing activities.

A percentage of both (4.1% vinyl and 2.7% latex) were visibly defective and proved not to be watertight. Of those which passed this elementary test, 20% latex gloves and 34% vinyl gloves would allow penetration by bacteria with failure increasing to 66% when a series of manipulations designed to simulate fifteen minutes of clinical activity in ITU took place. Failure was significantly greater with vinyl than with latex gloves. The problem of leakage in both types has been confirmed by *De Groot-Kosolcharoen and Jones (1989)* who investigated twenty-four different brands, all found to be defective, and *Kotilainen, Avato and Gantz (1990)* who found five brands defective.

Given this evidence of poor performance even when sharps handling has not been responsible for breaches in glove integrity, those whose work brings them into contact with blood and body fluids would be advised to avoid direct touching wherever possible. Spillages could be chemically decontaminated before any attempt is made to mop them up and blood-splashed linen could be touched wearing gloves at points where visible soiling is not apparent.

Although pressure from the unions for all nurses to be vaccinated against HBV is understandable and commendable, it may have a number of undesirable consequences. It may lead nurses to suppose that once vaccinated they may remain fully immune to the virus, a view which is erroneous, and which may encourage a sense of false security (*Stringer et al, 1991*). It may also detract from efforts made to identify nursing procedures and particular clinical settings where risk is particularly high. Such research may be valuable as HIV, for which no vaccine is currently available, may infect similar client ~~groups and is transmitted in the same ways. *Symington (1987)* is in favo~~ estimating local risks from blood bank data.

The high incidence of HIV in some populations has led certain authors to recommend routine screening of patients before surgery (*Shanson, 1991*), although results might be inaccurate because seroconversion could occur after testing was performed (*Gazzard and Wastell, 1990*). This view could be supported on the grounds that patients themselves would benefit because they could be offered prophylactic drugs at an earlier stage in the progression of HIV disease, but it is widely viewed as unethical (*Searle, 1987*) and is not endorsed by the RCN.

Some doctors have argued that double standards are practised in a society where on the one hand government health promotion campaigns urge household members not to share toothbrushes or razors in order to avoid infection yet consider risks to health-care staff minimal (*Goodacre, 1987*). Routine screening would not, in any case, overcome problems presented by emergency admission, because the results of tests take several days to become available. It therefore seems prudent to regard all blood as potentially contaminated (*Gurevich, 1988*). Even in communities where few individuals appear likely to carry blood-borne pathogens the results of confidential surveys suggest that a substantial proportion could still have had exposure to HIV and present potential risk to staff (*Havlicheck, Green and Plaisier, 1991*). *Gordin, Gilbert, Hawley et al (1990)* established that of six hundred and thirty-six patients admitted consecutively over a one month period, twenty-three were seropositive for HIV and twelve for HBV, although on the basis of interviews intended to identify patients, only twenty-two fell into the high risk category. These authors concluded that it would be safest to regard the blood of all patients as potentially infectious, a strategy which may help to reduce the distress reported among patients known to be carriers of parenteral infection (*Personal Paper, The Lancet, 1984*).

This view is supported by *King (1990)* who claims that in the past, attention given to avoiding risks of HBV to staff has not been matched by concern for the psychosocial needs of patient and family. It has long been recognised that over-zealous isolation precautions may result in lower quality nursing and medical care simply because the individual confined to a single room or isolation ward is overlooked *(Bagshawe et al, 1978)*. Incarceration in a single room is not necessary for all infected patients (*Garner and Kaiser 1972; Geelhoed, 1978)*, but extreme precautions may be implemented because nurses have an unrealistic view of the dangers of HBV, considering morbidity and mortality to be in excess of established rates (*Gould, 1985; Kelsey, 1992*).

According to *Goldmann (1991)* the value of gloves either in protecting the nurse from blood-borne pathogens or the patient from nosocomial infection remains to be determined. This author argues that the aims of 'body substance isolation' intended primarily to protect the patient (*Lynch et al, 1987*) and 'Universal Precautions' mainly concerned with protection of the employee although conferring some benefit for the patient (*CDC Morbidity and Mortality Weekly Report, 1987*) are not identical and merit careful evaluation in view of costs, especially gloves. However the work of *Gordin et al (1990)* suggests that glove use is safer than relying on detection of patients in high risk groups especially as a high proportion of nurses have cuts and abrasions on their hands (*Saghafi, Roselli, Francillon et al, 1992*).

**Limitations to the Barrier Protection Afforded by Gloves**

Even when intact, gloves are not impermeable to very small particles. ~~A number of research teams working independently have demonstrated tha~~ latex and polyethylene may allow the passage of viruses *(Arnold, Whitman, Fox et al, 1988; Klein et al, 1990; Korneiwicz, 1989)* while as previously discussed, leakage under stress is an established problem.

The evidence of a controlled trial by *Doebbeling, Pfaller, Houston et al (1988)* and laboratory studies by *Bagg, Jenkins and Barker (1990)* suggest that micro-organisms are capable of adhering to the outer surfaces of gloves and are not easily washed off, even with friction and drying. Their recommendation that gloves should be renewed, not washed between patient contacts appears sound in view of the isolation of HBV from the gloves of one nurse in the epidemiological study by *Polish et al (1992)*.

Despite this, *Stringer et al (1991)* observed thirty out of one hundred incidents when nurses wore gloves continuously for a range of tasks and recorded numerous instances when gloved hands were washed.

Gloves have been associated with allergy among patients as well as nurses (*Van Rijswijk, 1992*), which could result in further damage to hands.

**Inappropriate Glove Use**

A number of authors, although in favour of the protection afforded to patients and nurses by gloves, have observed wasteful and inappropriate use which have major cost implications. Using strict, pre-determined criteria of appropriate use, *Stringer et al (1991)* concluded that approximately half the gloves supplied to the wards of a 900-bed hospital over the summer of 1989 were used wastefully. The most frequent examples of appropriate use were changing dressings, care of incontinent patients and handling drainage tubes. The most frequent inappropriate uses included handing out bedpans and performing bedbaths. Only three occasions were documented when gloves should have been worn but were not. Staff appear to have been aware of the purposes of this study.

It has been estimated that in the UK considerable savings could be made if glove wearing on wards is carefully monitored and inappropriate use of expensive sterile surgeons' gloves curtailed (*Denton, 1991*). There is tentative evidence that for some tasks sterile brands may be safely replaced with cheaper non-sterile gloves (*Anderton and Aidoo, 1991*). *Jenner (1990-a)*, is also anxious about costs as well as sharing the concerns of *Stringer et al (op cit)* for the environment when large quantities of vinyl gloves are incinerated to release toxic chlorides. She rejects the blanket approach of Universal Precautions already adopted by many health authorities in the UK (*Wilson and Breedon, 1990*) in favour of a 'two-tier' approach to glove wearing. According to this system, gloves would be worn to clear up blood spillage, but experienced staff confident of their technique could dispense with gloves when performing venepuncture provided waterproof dressings occlude all cuts and abrasions. This avoids loss of manual dexterity associated with glove-wearing, while incorporation of viricidal surfactants into gloves could reduce risks to non-intact skin *(Arnold et al, 1988)*. Gloves do not prevent needle stick injuries or risks from other sharp instruments, however.

**Assessing Risks of Sharps Injury**

Although some sharps injuries have been deemed inevitable in theatre *Hussain et al, 1988*), surgeons have already identified situations where risks are particularly high and have made suggestions for modifying practice. In the UK a similar approach for ward-based activities may have been hampered by vociferous protests from the nursing unions that every nurse is at equal risk regardless of workplace or the particular activities routinely performed ~~(*Goodlad, 1991*). This view is not endorsed by *Symington (1987)*, a consultant~~ in occupational health who argues for the use of epidemiological markers to assess risk. His view is that only when the magnitude of the problem is assessed can appropriate action be taken.

This may involve interpretation of the incidence of infection in the area, whether it is increasing or decreasing and estimates of carrier rates in the community obtained from blood-bank data.

Commonsense suggests that the nurse who encounters bleeding patients most often is at greatest risk of developing parenteral infection, although those who perform injections and venepuncture most often may be less endangered because they become proficient. This is borne out by the results of a study among emergency service personnel which showed that needlestick injury was approximately four times more likely to occur among new than experienced employees (*Hochreiter and Barton, 1988*). Accidents among medical students are more likely to occur early in their clinical career (*Bock, Tong and Bernstein, 1981*). *Wormser, Joline and Duncanson, (1984)* revealed that a very high proportion of inoculation injuries followed attempts to recap needles after use, leading to the development of hospital policies forbidding this practice. The results of these studies are supported by a major endeavour to determine cause of injury in an 1100 bed hospital over a two year period (*Yassi and McGill, 1991*). Eighty-two per cent of seven hundred and ninety-nine accidental exposures to blood resulted through needlestick injury. Seventy-nine per cent occurred among inexperienced nurses and less than 10% each to medical staff and technicians more accustomed to handling equipment. Detailed analysis of the causes of sharps injury enabled these authors to modify their hospital procedure for performing intravenous manipulations which emerged as particularly hazardous. *Jagger et al (1990)* confirm that theatres and examination rooms are the most likely venue for sharps injury, although once again most (57%) involved nurses, presumably because they had fewer opportunities to learn safe practice than medical staff, only 8% of whom sustained damage.

It would thus appear that efforts to identify hospital settings where most injuries occur, and particularly hazardous practices, are worthwhile provided they are followed by positive efforts to enhance safe practice. This is emphasised by *Gartner (1992)*, who demonstrated decline in the number of sharps injuries following the introduction of a new intravenous system without steel needles. Detailed analysis showed that after the intervention, those few ($n = 2$ ) injuries still related to intravenous devices had occurred among nurses, indicating the need for a further campaign of awareness targeting this group.

The hand-maiden role of the nurse may be diminishing, but the tendency of nurses to clear away equipment that medical staff have used, particularly in theatre and clinics (*Collins and Kennedy, 1987*), may help to account for their high rates of injury, especially as unskilled tasks may be delegated to junior nurses.

**Reporting Sharps Injury**

Given their current preoccupation with the dangers of parenteral infection, it would be expected that when a sharps injury is sustained, hospital staff would be keen to follow hospital guidelines for reporting and so receive treatment, but this is not always the case (*Jenner, 1990b; Hamory, 1983; Saghafi et al, 1992*) perhaps because staff are not fully aware of the dangers (*Mansour, 1990*). Alternatively some may fear, erroneously at the present time, that to report injury would lead to enforced testing for HBV or HIV antibodies, throwing their career into jeopardy. Cross-infection from parenterally spread viruses is known to be low, however (*Papaevangelou et al, 1991*) and despite recent sensational evidence (*Schaffner, 1991*), it is generally accepted that risks to patients from infected staff are slender (*Alter, Chalmers and Freeman, 1975; Association for Practitioners in Infection Control: Position Paper, 1990*).

Reasons for failure to be vaccinated are more obscure. Some writers attribute this to lack of availability of the vaccine, which is costly for occupational health departments to provide for all employees, but *Trevelyan (1991)* acknowledged that most departments make some provision in the UK. The position is apparently much worse in the USA, according to *Goetz and Yu (1990)*, although their questionnaire study could be criticised in terms of poor response rate. Refusal appeared in one small-scale study to be related to belief that HIV might be contracted from the vaccine, with doubt concerning efficacy and practical difficulties. Seventeen per cent of respondents ($n$ = 88 unvaccinated) were unaware that a vaccine existed (*Spence and Dash, 1990)*. There is a need for occupational health staff to conduct local surveys among their own staff to identify barriers to vaccination; its advantages have been well demonstrated and side-effects are minimal (*Finch, 1987*).

### Provision of Sharps Disposal Units

A few authors insist that the provision of special sharps disposal bins is an unnecessary expense (*Daschner, 1989, 1991*) and in the past, purchasing has been with economy in mind (*Moir-Bussy, 1982*); but today this approach is difficult to justify in view of dangers documented previously from leakage through poorly fitting joins or penetration of flimsy cardboard containers (*Gwyther, 1989*).

Most authors agree that containers should be discarded when only two-thirds full to discourage staff inserting hands to 'force down' contents; also that choice should be made from the range of sizes now available so that large pieces of equipment can be discarded without disconnection. Department of Health specification concerning suitable sharps disposal exists and because this information as well as appropriate sharps containers is available, this is one area where nurses could practice safety.

However, twenty-one per cent of all injuries reported in the study by *Saghafi et al (1992)* occurred during disposal. More information about the system used to contain discarded sharps in this study would be of value.

**Knowledge of HBV, HIV and Compliance with Safety Precautions**

Attempts to determine nurses' theoretical knowledge and opinions about parenteral viral infections yielded results of a generally pessimistic nature although not all agree in detail. *Ho-Yen, Crossan and Walker (1984)* concluded from a questionnaire study yielding a rather low response rate that knowledge of HBV is poor among nurses, with little difference between those employed in different clinical settings. According to *Gould (1985)* who employed group interviews and achieved a high degree of rapport among nurses at ward level, subjects did not lack knowledge about HBV: they were unable to implement it effectively.

Both these studies were conducted before the availability of vaccine and the wave of publicity which accompanied campaigns of awareness in the nursing press. More recently *Kelsey (1992)* established that theoretical knowledge was superior among nurses employed on renal units compared to general wards but apparently not related to any special educational input, although it was significantly better among younger nurses.

With HIV, similarly, there is evidence that theoretical knowledge and attitudes could be improved (*Searle, 1987*). A questionnaire survey, conducted by this author among senior health care professionals in a geographical area where prevalence of HIV is known to be high, established large gaps in knowledge among a group who may be appealed to when there is need to develop policy for the care of this client group.

Nurses in the community have also reported themselves ill-prepared to provide care for the patient with HIV (*Bond, Rhodes,Phillips et al, 1990*). However, a small scale study by *Linden (1991)* indicated that theoretical knowledge of glove use was reasonable among staff on the ITU in a London teaching hospital and there is evidence that after the implementation of universal precautions the incidence of sharps injury declined with increased awareness of the need for gloves (*Saghafi et al, 1992*), although still with room for improvement. A study by *Kaczmarck, Moore, McCrohan et al (1992)* investigating glove use in twenty-two hospitals showed that compliance tended to be higher for some procedures than others (92.3% for blood gas monitoring compared to 77.6% for manipulating intravenous lines) and significantly lower in geographical areas where prevalence of AIDS was below the national average. *Becker et al (1990)* report disappointing results when attempts were made to improve safe sharps handling and disposal through educational campaigns, doctors' performance being less good than that of nurses. This was attributed to failure to tailor education to the needs of individuals working in different clinical settings. These authors believed that to be successful, future endeavours must be targeted towards specific groups, therefore assuming, in common with many other writers in the USA, that high and low-risk areas within the hospital exist (see *Kwapien et al, 1987; Spence and Dash, 1990*). Improved knowledge and observed compliance reported by *Lynch, Cummings, Roberts et al (1990)* following the implementation of a system of Body Substance Isolation Precautions could have occurred because trouble was taken to visit wards to reinforce input where attendance at formal study days proved poor. The information provided appears to have been specific, with feedback given to staff on rates of HAI. Possibly there is need to continue reinforcement. Staff in the study by *Saghaffi et al (1992)* indicated the need for frequent updating to maintain awareness.

**Summary: Chapter Four**

The literature reviewed in this chapter suggests that handling blood and body fluids poses a threat to hospital staff, including nurses at ward level. However, the degree of risk may vary between clinical settings according to the number of invasive nursing procedures performed, but this has never been investigated, so strategies to reduce risk in different situations are not well developed. Moreover, glovewearing and sharps handling and disposal are apparently poorly performed and not all nurses have availed themselves of the hepatitis B vaccine. There is scope for further investigation in this area.

**The Literature Review: Summary**

From the review of the literature it has emerged that HAI is a significant problem in Hospitals *(Meers et al, 1981; Donowitz et al, 1982)*, especially among the very sick (*French and Cheng, 1991*) and those undergoing invasive procedures (*Stamm, 1978*). Potentially the infection control nurse could play a vital role in reducing rates of HAI (*Haley et al, 1985*), or at least increase awareness of risks (*Worsley, 1988*), while policies and standards have been developed to safeguard patients and staff (*Simpson, 1991*), though with notable omissions (*Linden, 1991*). HAI is spread by contact, mainly directly via hands (*Steere and Mallison, 1975; Casewell and Phillips, 1977; Larson, 1988*), and could be reduced by stringent hand decontamination (*Casewell and Phillips, 1978*) and possibly use of gloves (*Lowbury et al, 1970*), which also play an important role protecting staff from parenteral pathogens (*Gurevich, 1988; Lynch et al, 1990*) though this is questioned by a few authors (*Goldmann, 1991*). Nevertheless, hand decontamination (*Albert and Condie, 1981; Broughall et al, 1984*) and blood and body fluid precautions (*Becker et al, 1990*) are often poorly executed. Numerous reasons have been suggested ranging from inadequate knowledge (*Sedgewick, 1984*), poor facilities (*Broughall et al, 1984*), poor motivation (*Bartzokas and Slade, 1991*) and high levels of ward activity (*Haley and Bregman, 1982*).

The results of these studies are, however, sometimes contradictory and inconclusive, while the influence of other variables such as clinical setting, professional nursing qualification and level of experience have apparently never been addressed. From this review the aims of the present study and its detailed objectives emerged. They are presented in the following chapter.

# CHAPTER FIVE

## METHOD

As indicated at the conclusion of Chapter Four, the decision to investigate nurses' infection control practice stemmed from questions unanswered within the existing literature. From this broad subject, hand decontamination was selected as the research topic owing to persuasive evidence that it remains the single most important method of preventing HAI (*Steere and Mallison, 1975; Reybrouck, 1983; Larson, 1988*). Glove-wearing was included as it became apparent that this was an issue closely related to hand hygiene (*Linden, 1991*). When the literature was reviewed it emerged that today gloves can be considered as important affording protection for the nurse as for the patient in view of the established high risk of exposure to potentially contaminated blood and body fluids (*Gurevich, 1988; Havlichek, et al, 1991*). A decision was taken to extend the study by incorporating an investigation of sharps use (handling and disposal) in view of the risk of parenteral infections.

### Aims of the Study

The broad aims of the study emerged from a review of the considerable literature on these subjects. From these, more specific aims and hypotheses were developed to explore aspects not previously examined.

## Overall Aims of the Study

1. To investigate nurses' knowledge and opinions of three essential aspects of infection control: hand decontamination, glove and sharps use.
2. To observe how knowledge and opinions of the above aspects of infection control are translated into clinical practice.
3. To compare and contrast knowledge, opinions and clinical practice between:
   i. Nurses employed in different clinical settings: intensive care, surgical and medical wards.
   ii. Experienced and less experienced nurses.
   iii. Nurses employed in hospitals with and without an infection control nurse.
4. To examine how levels of ward activity influence nurses' execution of infection control procedures.

## Specific Aims

1. To document the facilities available to help nurses prevent HAI through routine procedures including hand decontamination, glove and sharps use. This would involve the following comparisons:
   i. Two hospitals, one employing an infection control nurse, the other not.
   ii. Intensive care, surgical and medical units.
2. To investigate nurses' perceptions of HAI: prevalence, threats to themselves and their patients, educational opportunities regarding HAI and use of effective strategies for prevention.

Comparisons would be made between :

i. Two hospitals, one employing an infection control nurse, the other not.

ii. Intensive care, surgical and medical units.

iii. Experienced nurses (three years or more experience within their speciality) and less experienced nurses (less than three years within their speciality).

3. To investigate nurses' knowledge of infection control and HAI, with comparisons as above.
4. To observe three essential elements of infection control: hand decontamination, glove and sharps use with comparisons as above.
5. To examine the influence of workload and dependency on nurses' infection control practice.
6. To determine how knowledge and opinions of infection control are translated into clinical nursing practice.

The design of the study is shown in Figure 5.1.

## FIGURE 5.1 DESIGN OF THE STUDY

| Nurses in intensive care settings | Nurses on surgical wards | Nurses on medical wards |
|---|---|---|
| HOSPITAL A ($n$ = 30)<br><br>HOSPITAL B ($n$ = 30) | HOSPITAL A ($n$ = 30)<br><br>HOSPITAL B ($n$ = 30) | HOSPITAL A ($n$ = 30)<br><br>HOSPITAL B ($n$ = 30) |

↓

**COMPARISONS**

Non-participant observation of nursing practice

i. Hand decontamination

ii. Glove-wearing

iii. Sharps use

Nurses' knowledge of infection control

Nurses' opinions about infection control

COMPARISONS

COMPARISONS

↓

| HOSPITAL A | HOSPITAL B | Less Experienced Nurses | Experienced Nurses |
|---|---|---|---|
| Infection Control Nurse | No Infection Control Nurse | Less than three years in specialty | Three or more years in specialty |

## Sample

The sample for the main study would consist of qualified nurses (RGN, EN) employed in the intensive care, surgical and medical units of two hospitals, yielding a non-random sample of convenience. Following statistical advice this sample was drawn as follows:-

**Hospital A**

Infection control nurse employed and up-to-date guidelines on infection control.

| | |
|---|---|
| ITU | 30 nurses |
| Surgical Unit | 30 nurses, 10 each from three wards |
| Medical Unit | 30 nurses, 10 each from three wards |

**Hospital B**

No infection control nurse and infection control guidelines in need of updating.

| | |
|---|---|
| ITU | 30 nurses |
| Surgical Unit | 30 nurses, 10 each from three wards |
| Medical Unit | 30 nurses, 10 each from three wards |

A relatively large sample ($n$ = 80) was required to provide sufficient numbers of subjects within each of the three clinical settings in both hospitals to permit statistical analysis. The sample had to be sufficiently large to allow substantial numbers of nurses to wear gloves and use sharps. It was intended to include only nurses, not medical or paramedical staff, to overcome the problem, noted in Chapter Three, of one group of professionals criticising the professional activity of another group without fully understanding the constraints under which they were practising.

It was recognised that although wards might display individual patterns of behaviour depending on specialty or atmosphere, ten subjects would not be sufficient for quantitative analysis, particularly as a full complement might not be available in every case.

**The following hypotheses emerged:-**

1. Nurses employed in intensive care units will demonstrate greater knowledge and awareness of risks of HAI to themselves and to patients than nurses employed on surgical and medical wards.
2. Experienced nurses (more than three years clinical experience in the speciality) will demonstrate greater knowledge and awareness of risks of HAI to themselves and their patients than less experienced nurses (less than three years clinical experience in the speciality).
3. Nurses employed in a hospital where an infection control nurse is employed will have greater knowledge of risks of HAI to themselves and their patients than nurses employed in a hospital where no infection control nurse is employed.
4. At times when levels of clinical activity are high, nurses will not perform infection control procedures (hand decontamination, glove-wearing, safe sharps use) as frequently or as well as when levels of clinical activity are low.
5. Nurses employed in ITU will perform infection control measures more effectively than those on general surgical and medical wards.
6. Experienced nurses will perform infection control measures more effectively than less experienced nurses.

7. Nurses in a hospital where an infection control nurse is employed will perform infection control measures more effectively than those in a hospital with no infection control nurse.

**Methods of Data Collection**

In order to collect the volume of information required to fulfil the study aims it was necessary to employ multiple methods of data collection. The three main methods were:-

1. Non-participant observation of nurses' hand decontamination, glove-wearing and sharps use.
2. Questionnaires to elicit nurses' opinions and knowledge of HAI.
3. A short structured interview employing mainly open-ended questions to obtain more detailed information concerning nurses' opinions, the inclusion of infection control in learning opportunities and their perceptions of facilities available to enable them to perform infection control practises safely. Two instruments, Fulkerson's Scale (a measurement of the appropriateness of hand decontamination) and Feldman's Criteria (to assess quality of handwashing performance) already existed and there were numerous questionnaires to judge knowledge and opinions of infection control (Williams and Buckles, 1988; Larson and Killien, 1982). However, these either proved unsuitable for the present study or had to be considerably modified. The original instruments are shown in Appendix One and their final form in Appendix Two.

This chapter describes the extensive pilot work undertaken to refine and develop the instruments before discussing their use in the main study, but first ethical issues and the approach to the hospitals necessary before commencing fieldwork will be discussed.

**Approaching the Hospitals**

Hospital A was approached as the researcher was familiar with its infection control policies and clinical areas. The hospital was considered sufficiently large to accommodate extensive pilot studies and the main study without "contamination" of samples. Approval was sought and granted by the Nursing Ethics Committee and Senior Nurse Managers in the three units which would be involved in the study.

A meeting was held with the infection control nurse to clarify some areas of policy and a copy of the Infection Control Document was obtained.

Universal precautions as defined by *Wilson and Breedon (1990)* and *Goldmann (1991)* were not formally implemented throughout Hospital A, so when permission to collect data in a second hospital was sought, overtures were made to another institution where Universal Precautions were said to be implemented.

Unfortunately, difficulties with ethical clearance (not related to the nature of the study) prevented the involvement of this hospital. Data were therefore collected in Hospital B, chosen as a comparison because it had no infection control nurse.

There was no Nursing Ethics Committee in Hospital B, therefore an application was made to the Chairman of the Medical Ethics Committee. Senior nurse managers and the infection control officer were informed about the study before data collection began. No pilot work was conducted in Hospital B as the instruments required no further modification for use in this hospital.

**Ethical Issues**

Most authors previously observing hand decontamination have either deliberately concealed the purpose of the study (*Fox et al, 1974; Quraishi et al, 1984; Kaplan and McGucklin, 1986*) or provided misleading information (*Albert and Condie, 1981*).

Occasionally, staff though uninformed, are believed to have guessed the purpose of data collection (*Graham, 1990*). However, where researchers have been more honest, there seems little evidence of Hawthorn Effect (*Sedgwick, 1984; Larson et al, 1986; Leonard, 1986; Doebbeling et al, 1992*).

The researcher assured senior nurse managers that in the proposed study the following would be ensured:-

1. All subjects would be informed of the aspects of infection control under scrutiny. One of the purposes of the interview would be to emphasise confidentiality and to answer questions about the study or infection control. Subjects would be given a study number allowing observation and questionnaire data to be matched. They could withdraw from the study at any time if desired.

2. The hospitals would not be identified in connection with the study.
3. Feedback would be provided to clinical staff and their managers if they wished.
4. The permission of patients and relatives would be sought verbally during data collection as necessary. They would be informed that staff, not patients, were the objects of the study.

### The Research Team

One researcher (DJG) was responsible for the design of the study and the selection and developemnt of the instruments. She collected much of the pilot data and most of the data for the main study (intensive care units and Wards 3, 5, 12 and 13). An assistant collected the remaining data, allowing valuable inter-rater reliability testing of the instruments. The same individual was always responsible for data collection in one particular ward to establish rapport with staff.

### Developing and Testing the Instruments

Development and testing the instruments used to document observed infection control practice, knowledge and opinions will be discussed separately in the following sections, although during pilot studies much of this work took place concurrently and some ideas generated through piloting the observation schedule influenced design of the questionnaires and the reverse. More changes were necessary than anticipated and all instruments underwent considerable modification.

### Non-Participant Observation

This involved pre-pilot work to see "what there was to see" and determine the feasibility of observation.

The researcher spent several days on the ITU, where she had no clinical experience, becoming familiar with the procedures commonly undertaken. This was invaluable preparation for data collection, but time-consuming. As a result, it was decided that only one individual would collect data from ITU. Pre-pilot studies on general wards followed, involving both data collectors.

### Pre-pilot Studies of Observation

Initially two instruments were developed to collect data pertaining to hand decontamination, glove and sharps use:-

1. **An observation schedule** developed for the study to document:-
   i. Choice of agent, duration and frequency of hand decontamination.
   ii. Activities for which sterile and non-sterile gloves were worn.
   iii. Frequency of safe and unsafe sharps use.

Clearly a scheme of appropriateness had to be developed for each, but this proved so complex that it is discussed separately (see page 156).

2. **An observation checklist** to document quality of hand hygiene validated by *Larson and Lusk (1985)*, from Feldman's Criteria (see Chapter Three).

Testing the schedule and checklist are considered separately below.

## Aims of Pre-pilot Observation with the Schedule

The aims of pre-pilot observation with the schedule were to:

1. Determine optimal locations on the ward for observation.
2. Document nurses' reactions to observation and evidence of Hawthorn Effect.
3. Determine optimal length of time for each episode of observation.
4. Note facilities available for infection control on a typical ward in Hospital A.
5. Test feasibility of the observation schedule.
6. Document any other features of the ward (e.g. nursing philosophy, management style) which might influence infection prevention activities.

## Conducting Pre-pilot Observation with the Schedule

Pre-pilot testing took place over ten week days on Ward A, Hospital A as shown on Table 5.1. This was a 30-bed orthopaedic ward selected for pre-pilot work as it would contain surgical patients and those with chronic health problems likely to be encountered on medical wards.

**TABLE 5.1 - Observation on Pre-pilot Ward (A)**

| Location | N° Episodes | N° Hours |
|---|---|---|
| Sluice | 1 | 2 |
| Treatment Room | 1 | 2 |
| Ward Sinks * | 3 | 6 |
| Shadowing Nurses | 6 | 12 |
| **Total** | **11** | **22** |

* Ward sinks were positioned in the main ward corridor, adjacent to patient bays.

**Pre-pilot Results with the Observation Schedule**

The results of pre-pilot observation will be discussed in terms of the aims.

1. Observation in the ward treatment room and sluice yielded very little data as the nurses entered principally to collect or dispose of equipment. Hand decontamination occurred at sinks in the main ward corridor. Nurses said the sluice was an unsuitable environment in which to perform hand hygiene because it was not clean and generally unpleasant. Observation at sinks in the main ward corridor adjacent to bays yielded considerable data although it was not always possible to witness activities which had occurred immediately before or after decontamination. This was overcome by 'shadowing' individual nurses.
2. The nurses did not object to observation or shadowing and it was acceptable to patients for observation to continue at the bedside, even when curtains were drawn.
3. Initially each observation episode was planned to continue for a trial period of two hours because *Phillips and Casewell (1977)* showed that considerable potential for cross infection existed within this relatively short time span. This proved optimal as the researchers became tired and attention wavered, introducing the possibility of inaccurate recordings.
4. It became apparent that levels of ward activity might influence the amount of time available to conduct infection control practices effectively and the degree of priority afforded, as noted by other authors (*Lowbury et al, 1970; Haley and Bregman, 1982; Noone et al, 1983*).

Throughout the pre-pilot study nurses commented on the unusual quietness of the ward and lack of heavily dependent patients. The possibility of incorporating a dependency measure into the study was considered, and a simple method, developed by *Barr (1964)*, was selected.

5. The observation schedule proved rather cramped, with insufficient space to make comments which would later help with the interpretation of data. A new format was therefore developed.

**Aims of Pre-pilot Observation with the Checklist (Feldman's Criteria)**

*Larson and Lusk (1985)* claim that their checklist developed from Feldman's Criteria to document quality of handwashing technique incorporates provision for inter-rater reliability testing and is valid as it has been subject to testing and comments by clinicians, but reports of its use have never featured prominently in the literature. Owing to the lack of Hawthorn Effect allegedly associated with handwashing it was planned that nurses would be asked to provide demonstrations once they were familiar with the research team so that quality could be studied in-depth, but during the pre-pilot study the checklist was tested on any nurse sufficiently near for detailed observation and on the data collectors themselves, who judged each other's performance with routine decontamination and when some components (e.g. drying) were deliberately omitted or poorly performed.

The aims of the pre-pilot observation were to :

1. Explore utility of the checklist.
2. Explore possible evidence of Hawthorn Effect.
3. Determine whether the checklist, developed several years earlier in the USA, could still be regarded as a valid indicator of hand-washing quality.

**Results of Pre-pilot Observation with the Checklist**

It rapidly became apparent that the checklist was unsuitable, leading to a detailed critique shown on Table 5.2. It lacked utility and was too complex for routine use in any fieldwork situation, irrespective of whether demonstration or routine hand-washing was provided, and it could not be considered a valid measure of the quality of hand-washing in the UK.

**Changes to Non-participant observation resulting from the Pre-pilot Study**

It was decided to abandon the use of a separate checklist to document quality of hand decontamination, but to incorporate two items in modified form onto the new observation schedule :

1. Item 4 - (surfaces covered) was retained as this is an important aspect of hand hygiene frequently overlooked but possible to document (*Linden, 1991*).
2. Item 7 - (drying) was retained as research evidence suggests it to be important in reducing hand contamination.

The development of the observation schedule continued throughout Pilot Study I and 2, proving the most demanding aspect of instrument construction and refinement.

**TABLE 5.2 Critique of Feldman's Criteria for judging quality of handwashing technique (as validated by *Larson and Lusk (1985)***

| CRITERION | SCORE | WEIGHT | MAXIMUM TOTAL | CRITIQUE |
|---|---|---|---|---|
| 1. SOAP<br>Visible bubbles<br>No visible bubbles<br>No soap | <br>2<br>1<br>0 | x 2 | 4 | Soap is not always used. There is no evidence that soap bubbles are associated with good technique. |
| 2. SPLASHING<br>No splashing on clothes or floor<br>Minimal splashing on clothes or floor<br>Vigorous splashing on clothes and floor | <br>2<br>1<br>0 | x 1 | 2 | Clothes and floor are not usual sources of HAI (*Babb et al, 1983; Danforth et al 1987*) |
| 3. FRICTION (rubbing)<br>Vigorous friction (visible arm movement and/or audible running sounds) | <br>2<br>1 | x 2 | 2 | Friction to remove bacteria is also provided by drying (*Sprunt et al 1973*) |
| 4. SURFACES COVERED<br>Dorsal, palmar, interdigital areas covered<br>Two of above surfaces covered<br>One surface only covered | <br>2<br>1<br>0 | x 1 | 4 | Thoroughness is regarded as an important part of technique (*Taylor, 1978; Linden, 1991 Bowell, 1992*) |
| 5. HAND POSITION<br>Hands held down so water drains from fingers<br>Hands held parallel with arms | <br>2<br>1 | x 1 | 2 | There is no substantiating research evidence for this criterion |
| 6. RINSE<br>All surfaces rinsed<br>Only parts of hands rinsed<br>No rinsing | <br>2<br>1<br>0 | x 1 | 2 | As above |
| 7. DRYING<br>Dried hands thoroughly, turned off faucets with paper towel<br>Dried hands, turned off faucet with hands (unless knee, foot or elbow controlled sink)<br>Did not dry hands | <br>2<br>1<br>0 | x 1 | 2 | Drying reduces counts of bacteria remaining after washing (*Sprunt et al, 1973; Ansari et al, 1991*).<br>Wet hands transfer more infection than dry ones (*Marples and Towers, 1978; Ojajarvi, 1981; Mackintosh and Hoffman, 1984* |
| **TOTAL** | | | **20** | |

Duration = time from initial placing of soap on the hands to rinsing off the soap

## Pilot Studies of Non-participant Observation

### Pilot Study I

### Aims of Pilot Study I Observation

The aims of the first pilot study were to:

1. Test feasibility of the observation schedule in its new format.
2. Determine whether the same locations and means of observation remained optimal on another ward of the same layout.
3. Refine and extend the categories of activities to be observed as necessary, with care to ensure that they remained mutually exclusive.
4. Examine the range of data which could be collected during systematic episodes of observation, two hours in duration.
5. Develop a method of testing inter-rater reliability.

### Conducting Observation during Pilot Study I

Observation during Pilot Study I took place on Ward B, a second orthopaedic ward in Hospital A over five week days. A longer test period had been anticipated but observation was truncated as new limitations to the approach rapidly became apparent. Table 5.3 below shows how observation was organised:-

**TABLE 5.3 Non-participant Observation during Pilot Study 1 (Ward B).**

| Location | N° Episodes | N° Hours |
|---|---|---|
| Sluice | 1 | 2 |
| Treatment Room | 1 | 2 |
| Ward Sinks* | 3 | 6 |
| Shadowing Nurses | 2 | 4 |
| Total | 7 | 14 |

**Results of observation from Pilot Study I**

Results will be discussed in terms of the aims:-

1. The new format of the observation schedule was more convenient to complete and examine afterwards.
2. Shadowing individual nurses again provided most information.
3. Data from complete episodes of observation were inspected to give a clear indication of the type of information available for collection and limitations of the schedule obtaining it. Formal analysis was not undertaken at this stage as the changes made to the instruments during development rendered information gathered so far non-uniform. It was apparent that the two data collectors were not recording information systematically through lack of consensus of what should constitute a single unit of nursing activity.

The researcher subdivided complex procedures consisting of 'clean' and 'dirty' activities (e.g. aseptic technique and consequent disposal of materials) into small units and completed a schedule for each unit. The assistant regarded the entire procedure as a single unit of activity with the result that several decontamination episodes would be documented on the same schedule. This caused confusion, loss of data where asepsis was breached and lack of direct comparability. The researcher recorded activities when hands should have been decontaminated but were omitted, while the assistant did not.

To achieve concensus it was agreed that each patient contact would be regarded as a single unit of nursing activity (i.e. hands might need to be decontaminated more than once when performing a dressing).

A separate observation schedule would be completed for each contact.

It was apparent that it would not be possible to test inter-rater reliability by both data collectors occasionally observing the same nurse as subjects stated that this would be unacceptable to themselves and patients.

**Pilot Study 2**

**Aims of Pilot Study 2**

The aims of Pilot Study 2 were to:-

1. Ensure that the changes made to the observation schedule were satisfactory when used to collect data on a similar ward.
2. To explore whether the same instrument could produce comparable data on an intensive care unit.
3. To develop a method of coding and storing data.

**Results of Pilot Study 2**

Pilot Study 2 was conducted on Ward C Hospital A, a 28-bed orthopaedic ward selected because it had the same type of patients, ward layout and skill mix as the wards used in the earlier pilot studies.

A high dependency cardiovascular unit was also selected because it was geographically separate from the main intensive care unit where data for the main study would be collected and the staff had no contact with one another. It was established that the observation schedule obtained the required data in its existing form on the ward and unit. A method of coding and storing data was developed and the system of preliminary analysis (described at the end of this chapter) was rehearsed.

A number of other issues were resolved during Pilot Study 2. It was decided that as ward routines and levels of activity vary according to time of day and day of the week, data for the Main Study would be collected during episodes of observation occurring during the morning, afternoon or evening and sometimes weekends as well as weekdays. Also, as ward layout could influence findings, only wards of the same or very similar layout would be included in the Main Study.

**Determining a scheme of appropriateness for hand decontamination**

From Chapter Three it is apparent that appropriateness of decontamination has been judged in different ways. Three broad schemes exist.

*Fox et al (1974)* developed the earliest approach, Fulkerson's Scale, which involves a complex system of ranking activities into clean or dirty.

Although later simplified by *Larson and Lusk (1985)* this seemed unwieldy for use in a large fieldwork investigation and would not allow the researcher to make clinical judgements which might depend on circumstance. It was not adopted for this study.

According to *Albert and Condie (1981)* hand decontamination should follow every patient contact, no matter how brief. These authors worked exclusively in ITU, where patients are at higher risk than on general wards.

However, as every action the nurse performed was recorded on its own sheet of the observation schedule, it was possible to calculate appropriateness in this way, so that direct comparison could be made with the widely quoted work of *Albert and Condie.* This was the Rigor Score, which was therefore the same as hand decontamination frequency.

Other authors, collecting data or general wards, suggest that hand decontamination following every patient contact, though ideal, is not practical and recommend that appropriateness should be judged according to whether decontamination follows activities in which hands are likely to become heavily decontaminated (*Broughall et al, 1984*).
A list of such activities was suggested in the published article, although not exhaustive.

It was decided to employ a second, more liberal approach in the present study to give a Liberal Appropriateness Score, so that activities would be classified according to whether hand decontamination should be regarded as essential.

Sufficient space existed on the observation schedule for each activity to be recorded in detail to allow later interpretation of events in context. Under different circumstances the same activity could be regarded as clean or dirty. For example, handling bedclothes is generally dirty as sheets are a source of bacteria and skin scales (*Litsky, 1971*) which can be transferred to hands (*Overton, 1988*). However, if bedclothes had been changed only a few minutes earlier this action would be clean because the hospital laundering service effectively destroys bacteria (*Ayliffe, Collins and Taylor, 1990*).

Decontamination would be considered essential before aseptic technique and during procedures if asepsis was breached.

A possible drawback in this scheme was that it might not always be possible to "attach" a particular episode of decontamination to a given procedure: the same handwash might belong to the end of one procedure, the beginning of the next or be intended to do for both.

This is one of the drawbacks inherent in the method of non-participant observation: motivation cannot be explored. Table 5.4 below outlines those procedures for which decontamination was considered mandatory.

TABLE 5.4

| **Activities after which hand decontamination is mandatory (adapted from *Broughall, Marshman and Jackson, 1984*)** |
|---|
| 1 Contact with excreta/items contaminated with faeces, urine and vomit eg. bedpans, urinals, vomit bowls, following catheterisation, handling catheter drainage bags, soiled bedclothes. |
| 2 Contact with blood or body fluids/items contaminated with blood or body fluids eg. venepuncture, peritoneal drainage, bloodstained bedclothes, following dressings, injections, after disposal or handling potentially contaminated waste. |
| 3 After extensive patient contact, eg. bedbathing, the water is likely to contain large numbers of bacteria (*Greaves, 1985*), bath hoists harbour bacteria (*Murdoch, 1990*) or touching mucous membranes (mouth, perineal area). |
| 4 After touching anything in the environment which can be assumed to be potentially heavily contaminated: floors, wastebins, after damp dusting, handling flowers or plants (*Schroth et al, 1973*). Although there is evidence that the environment contributes minimally to HAI, the hands can act as the bridge between environmental reservoirs and the patient. |
| 5 When moving from one patient to another or after handling supportive equipment/the immediate environment of one patient and moving to the next. |
| 6 After contacts with the nurse's own body secretions eg. wiping nose (see *Isaacs et al, 1991*). |
| 7 After contact with patients nursed in isolation because they are known to be infected. |
| 8 Following a breach in aseptic technique. |

According to the Liberal Appropriateness Score, frequency and appropriateness remained distinct components of hand decontamination, requiring value judgement on the part of the researcher during analysis. With the Rigorous Approach, no value judgements were necessary. During pilot work and later data collection frequency did not approach the very high levels recorded by *Ojajarvi et al (1977)*, so the question of a "maximum" level of safety above which no further decontaminations should be performed did not arise.

**Extent of the Clinical Environment and Exclusions from Observed Data**

During pilot work decisions were made concerning the extent of the immediate clinical environment, as this would influence whether decontamination would be essential on the Rigor Scheme.

From the literature, the immediate clinical environment was taken to include anything touching the patient (eg. bedclothes, crockery) but not more distant objects (e.g. television sets) handled only occasionally and unlikely to provide a hospitable environment for the development of a reservoir of infection.

The floor is recognised as harbouring bacteria (*Ayliffe et al, 1966*) which only under special circumstances become transferred to patients (*Bentham, 1979*), but in pilot studies nurses often touched the floor to retrieve objects and as a floor is not regarded as socially clean, this was recorded as a "dirty" manoeuvre.

During outbreaks of infection, bedside curtains have become contaminated (*Speller et al, 1976*), and even when no outbreak is apparent, bacteria have been isolated from nurses' hands after touching curtains (*Sanderson and Weissler, 1992*). Again, during pilot studies curtains were often handled by nurses, but as these recordings would have added an enormous burden to already detailed and exhaustive data collection and because curtains are generally regarded as "socially clean" an arbitrary decision not to include handling curtains was taken.

A further concession, not to reduce the volume of observational data, but perhaps reducing its richness, involved the classification of all intra-vascular lines under one category, irrespective of whether veins or arteries had been cannulated or whether lines were peripheral or central. This was necessary as it was not always possible to observe precisely which line was handled, particularly when events occurred in rapid sequence or when there was a crowd around the bedside. This was unfortunate in view of evidence that central lines are associated with higher rates of sepsis than peripheral lines, (*Nystrom et al, 1983*) but was inevitable.

**Determining a scheme of appropriateness for glove use**

No national guidelines for glove wearing are available in the UK and no mention of their use other than for isolation precautions was made in the infection control policies of either Hospital A or B, leading to difficulties when attempting to define acceptable standards of practice for the present study. Discussions were held with the infection control nurse in Hospital A to confirm the recommendations given verbally to staff when enquiries were made.

Where doubt existed, practice suggested by a popular nursing procedure book was adopted (see *Pritchard and David, 1989*), as the infection control nurse referred staff to this text.

In the absence of an infection control nurse in Hospital B, the same criteria were adopted for uniformity and because the same textbook is used widely by clinical staff and those in colleges of nursing who teach staff the theory underlying procedures.

**TABLE 5.5 Categories of Glove Use**

(after *Linden 1990)*

| | |
|---|---|
| **Grade 1.** | **Procedures where sterile gloves are recommended** |
| 1 | Contact with tracheal mucosa: e.g. Endotracheal suction; Tracheostomy suction ; Removal of endotracheal tube |
| 2 | Invasive procedures: e.g. Urinary catheterisation; Manipulation of intravascular lines |
| 3 | Direct contact (no forceps) with non-intact skin: e.g Handling infected wounds; Removal of chest drain |
| **Grade 2.** | **Procedures where unsterile gloves are recommended** |
| 1 | Potential contact with blood: e.g. Withdrawing blood samples from intravascular lines; Connecting or removal of intravascular infusion lines; Changing thoracotomy drainage bottles |
| 2 | Indirect contact (no forceps) with non-intact skin: e.g. Removal of dressings |
| 3 | Potential contact with excreta: e.g. Removal of urinary catheter; Handling of soiled linen; Emptying urine drainage bag; Giving suppositories |
| **Grade 3.** | **Procedures where gloves need not be worn** |
| 1 | Contact with intravenous infusions: e.g. Giving intravenous medications |
| 2 | Indirect contact with mucous membranes: e.g. Taping endotracheal tube; Mouth care (forceps used); Eye care (forceps used) |
| 3 | Indirect contact with gastric contents: e.g. Nasogastric feeding or medications |
| 4 | Contact with intact skin: e.g. Turning patient; Washing patient (unless incontinent) |
| 5 | Contact with support equipment: e.g. Changing ventilator tubing |

The scheme is similar to that adopted by *Linden (1990)* (see Table 5.5) and is broadly in agreement with CDC recommendations (1988).

From Chapter Four, it was decided to regard continuous glove wearing and glove washing as incorrect behaviour and to consider that hands should be decontaminated after use because gloves may be permeable to viruses and easily damaged, although this may not always be visible.

### Determining a Scheme of Appropriateness for Safe Sharps Use

Criteria for safe sharps handling and disposal were drawn from the literature and mirrored that existing in Hospital A: disposal should occur as soon as practical after use, into a designated container, by the individual who had used it. Recapping syringes was not safe practice.

The following section describes the detailed scoring systems for each component of decontamination, glove and sharps designed for the study.

### Quantifying Infection Control Performance: the Scoring Systems

Once criteria for judging acceptable standards of hand decontamination, glove and sharps use had been developed, a scoring system was devised to quantify how well each had been performed.

Frequency of hand decontamination assessed rigorously (Rigor Score) and according to a less stringent approach (the Liberal Appropriateness Score) was already in quantifiable form while duration could be recorded in seconds. Frequency of glove and sharps use could be counted.

The remaining facets of behaviour (choice of agent, drying, surfaces decontaminated, disposal, appropriateness of glove type, whether or not sharps were placed straight into a container without recapping) had to be converted into a form amenable to statistical analysis. This involved further consideration of how behaviour should be judged.

**Hand Decontamination**

**Choice of Agent**

Although there is little doubt that aqueous and alcoholic chlorhexidine have superior bactericidal effects to soap and water, as well as a degree of residual activity, their performance in the clinical situation has been less thoroughly evaluated than in the laboratory (see Chapter Three). Field studies have mainly been conducted in recognised high risk areas and it was already known that in many hospitals these expensive agents are not recommended for routine use on wards. In Hospital A the Infection Control Policy stipulated that chlorhexidine should be used in ITU, but liquid soap from a wall dispenser was considered as adequate in wards. Alcoholic chlorhexidine was available as a handrub. In ITU it was recommended for routine use between patient contacts when the hands were socially clean, as suggested by manufacturers. On general wards it was supplied for use only before and during aseptic technique. The use of bar soap by staff was banned. In Hospital B no advice was available, but the same agents were provided, so the same scoring system was adopted for both hospitals (see Table 5.6).

**TABLE 5.6 Scoring System for Choice of Agent**

| | | |
|---|---|---|
| ITU | chlorhexidine appropriate | score 12 |
| | Liquid soap | score 6 |
| | No agent/bar soap | score 0 |
| | Handrub when hands are socially clean | score 12 |
| | Handrub when hands are not socially clean | score 6 |
| General Wards | Liquid soap appropriate | score 12 |
| | Chlorhexidine | score 6 |
| | No agent/bar soap | score 0 |
| | Handrub before/during asepsis | score 12 |
| | Handrub for other use | score 6 |

A score of 6 was awarded when an inappropriate agent was employed on the basis that any attempt at decontamination is better than none.

### Drying

Nurses who dried hands thoroughly (brisk use of paper towels, no evidence of residual moisture) would be awarded a score of 12, as there is evidence that damp surfaces transfer bacteria more readily than dry ones (*Marples and Towers, 1978; Mackintosh and Hoffman, 1984*). If hands were not dried thoroughly or gleamed with residual moisture a score of 6 would be awarded. Failure to dry would attract a score of 0. This system is summarised on Table 5.7.

**TABLE 5.7 Scoring System for Drying**

| | |
|---|---|
| Thorough drying | Score 12 |
| Residual moisture | Score 6 |
| No drying | Score 0 |

**Surfaces Score (Thoroughness of Decontamination)**

A score of 12 was awarded for thorough decontamination. The hands were considered to have three surfaces (see *Taylor 1978; Linden, 1991*). A score of 4 was awarded for each surface decontaminated (see Table 5.8).

**TABLE 5.8 Surfaces Score**

| | |
|---|---|
| Interdigital Surface | Score 4 |
| Palmar Surface | Score 4 |
| Dorsal Surface | Score 4 |
| | Score 12 |

The amount of agent used may influence thoroughness but only one study to address this variable was found (*Larson, Eke, Wilder and Laughton, 1987*). However, a decision was taken not to include a measure of quantity in this study as it would be time consuming. Quantity was likely to be similar for all nurses as the delivery systems of all agents used throughout Hospitals A and B were designed to release a standard dose of 5 ml.

**Disposal Score**

Nurses were awarded a score of 12 if they disposed of paper towels without recontaminating hands and a score of 0 if they touched the receptacle, because this provides potential for recontamination.

**Weighting the Scores**

Each component of hand decontamination was scored out of 12 because it was not known whether any individual component was more or less important than the others.

When conventional handwashing was performed, all five components would all be applicable. When handrub was used scores for drying and disposal would be redundant, so clearly the two techniques would need to be analysed separately. With data from the Main Study it was possible to calculate an overall score for quality of handwashing, the Amalgamated Handwashing Score (see Chapter 6). This was not possible when handrub was used. Table 5.9 below summarises the Scoring System for all facets of hand decontamination.

**TABLE 5.9**

| | Scoring System for all facets of hand decontamination | | |
|---|---|---|---|
| i | **Duration**<br>Raw data in seconds taken as the score for each episode. | | |
| ii | **Frequency/Rigorous Approach**<br>Inspection of the raw data before formal analysis revealed enormous variation in the number of patient contacts made during each period of observation. Frequency was therefore calculated as the percentage of hand decontamination episodes made during the two hours : ie. if fifty contacts occurred but hand decontamination followed only ten times, frequency would be calculated as 5%. | | |
| iii | **Appropriateness of Timing**<br>Two scores were calculated :<br>A. The Rigorous Approach - the same as the Frequency score above.<br>B. The Liberal Appropriateness score adapted from *Broughall, Marshman and Jackson* (1984).<br><br>This was calculated as a percentage of total mandatory decontaminations | | |
| iv | **Choice of Appropriate Agent** | | |
| | No agent/bar soap | = | score 0 |
| | Inappropriate agent | = | score 6 |
| | Appropriate agent | = | score 12 |
| v | **Number of surfaces decontaminated** | | |
| | 1 hand surface decontaminated | = | score 4 |
| | 2 hand surfaces decontaminated | = | score 8 |
| | 3 hand surfaces decontaminated | = | score 12 |
| vi* | **Thoroughness of drying** | | |
| | Thorough drying | = | score 12 |
| | Drying not thorough | = | score 6 |
| | No attempt to dry | = | score 0 |
| vii* | **Disposal** | | |
| | ~~Disposal without contaminating hands~~ | ~~=~~ | ~~score 12~~ |
| | Hands recontaminated | = | score 0 |

* excludes handrub

### Glove use

The scoring system devised by *Stringer et al, (1991)* was adopted (see Table 5.10).

**TABLE 5.10 Scoring System for Appropriate Glove Use**

(after *Stringer et al, 1991*)

| | | |
|---|---|---|
| 1 | Occasion when gloves should be worn correctly identified and appropriate gloves worn | score 12. |
| | Occasion when gloves should be worn correctly identified but inappropriate gloves worn | score 6. |
| 2 | Occasions when gloves should be worn not identified | score 0. |
| 3 | Gloves worn when they need not have been | score 0. |

A score of 6 would be awarded even if inappropriate gloves were selected on the basis that some protection for the patient or nurse is better than none. Some procedures for which sterile gloves have traditionally been recommended may be safe with non-sterile brands, but evidence is tentative and research is ongoing (*Anderton and Aidoo, 1991*). Where doubt existed it was felt that nurses should not be penalised. The recommendations of two tier glove use (*Jenner, 1990*-a) could be ignored for this study, as venepuncture, for which gloves could be considered optional, was not performed by nurses. In ITU samples were drawn from arterial lines.

### Sharps Use

The scoring system for sharps use is shown on Table 5.11.

**TABLE 5.11 Scoring System for Safe Sharps Use**

| | | |
|---|---|---|
| 1 | | |
| i | Safe handling (no separation or recapping) | score = 12 |
| ii | Unsafe handling | score = 0 |
| 2 | | |
| i | Safe disposal (immediate) | score = 12 |
| ii | Unsafe disposal (delayed) | score = 0 |

### Incidents of Very Poor Practice

Throughout data collection a number of incidents of very poor practice (IVPP) were noted independently by both researchers ranging from examples of unaesthetic behaviour (e.g. drawing up a drug for intravenous injection, then inserting the end of the full syringe in the mouth and sucking it as a pencil might be sucked) to dangerous behaviour (putting a hand into a full sharps bin to press down the contents). These were documented on the observation schedule.

### Hawthorn Effect

One of the accepted disadvantages of non-participant observation is that the presence of the data collector must in some way alter the normal behaviour of subjects, especially if they are aware of the purpose of the study. In this section evidence from the literature and the findings of this study itself are used to argue that although the presence of the data collectors must have had some influence, this was not always predictable and for many subjects not marked.

Research documenting infection control practice provides little information about the researchers' demeanour with the exception of the study by *Larson,McGinley and Grove (1986)*, perhaps because data collection continued for months and involved the same twenty-two subjects. Here some interaction must have occurred, as the authors were reassured by subjects that they were observing usual behaviour.

In this study subjects knew the purpose of the research, but in others they were not told or deliberately misled (see Chapter Three). However, behaviour might have changed purely because outsiders were present.

The problem was tackled in the present study by informing subjects that decontamination, glove and sharps use were observed for ethical purposes but omitting information about the criteria used to determine safe practice.

The researcher imagined that during data collection she would remain polite but impartial toward subjects. Witnessing incidents of poor practice occasionally jeopardised impartiality, but even more difficult to ignore was the conversation made by subjects when not busy. In Hospital A staff frequently mentioned their dissatisfaction at work, particularly poor facilities, while in Hospital B comments were made about current difficulties obtaining promotion or competition for places on courses. General difficulties at work were mentioned, providing information about ward atmosphere. The researcher felt she became immersed in the ward atmosphere, especially in ITU, where data collection continued for months.

When she observed a nurse caring for a critically ill patient during the time that a decision to discontinue his life support equipment was made, she became aware that she was providing support to the nurse, who later acknowledged this. Thus, although they did not participate in clinical nursing procedures, the data collectors in some respects became temporary members of the ward team and ceased to be viewed as outsiders.

Their effect on the observational data was probably not systematic. When subjects were busy they appeared to forget they were being observed, reacting with surprise when they were thanked. Under these circumstances it would be tempting to share the conclusion of *Doebbeling et al (1992)* of absence of Hawthorn Effect, but it would seem naive to imagine that on some nurses, at least, the researcher made no impact.

Frequency of decontamination and glove use were probably increased for some subjects so the Rigor score would be inflated, but not necessarily the Liberal Appropriateness Score, because some of the extra decontaminations might not have been essential. To some it was obvious that duration was recorded, but not to others, judging by the number of times they spoke to the researcher, unaware that she was counting.

A number of other aspects of behaviour, documented, but not forming part of the planned data collection, suggest that for many subjects, Hawthorn Effect was minimal. Ten nurses performed dangerous or unaesthetic actions when they knew they were being watched.

It is difficult to accept that a nurse putting her hand in a sharps box or tearing a strip of adhesive tape with her teeth could have been acutely conscious of the researcher's presence (see Chapter Six). Similarly, nurses touched their faces, including the nose and mucous membranes or the floor, without decontaminating hands. This behaviour has been documented by other authors (*Cookson et al, 1985; Carter, 1990*). Touching the face may be so involuntary that subjects are unaware of their behaviour. This appears to be the manner in which one of the most widespread infections, the common cold, is disseminated (*Gwaltney et al, 1978*) and it could play a part in the spread of staphylococcal infection.

The issue of whether the nurses cared about what the researcher thought or documented must also be addressed. It was apparent that they did, judging by requests for information on how well they or the ward had performed and the concerns they showed about infection control when interviewed. Subject 156, having thrown a sharp instrument across a room, commented to the researcher on her anxiety to perform well in all aspects of her work.

Overall, the effect of the researcher on subjects and ultimately on the data seems complex and unsystematic, but the experience for the nurses did not appear intrusive or threatening. Variation undoubtedly occurred depending on personal outlook as well as levels of clinical activity.

### The Knowledge Questionnaires

Although poor hand decontamination has been attributed to lack of knowledge and there have been numerous campaigns to enhance handwashing performance, glove and sharps use through educational interventions (see Chapters Three and Four), few instruments designed to measure baseline levels of knowledge could be found. Many published articles contained only extracts of questionnaires. It was therefore necessary to design questionnaires to assess understanding of theoretical and applied microbiology. Each consisted of a variety of short answer items in different styles (listing, ticking boxes) to maintain interest and reduce response set (*Topf, 1986*). Multiple choice questions were avoided because they are difficult to develop and test (*Cheveney, 1988; Farley, 1989*) and could be reminiscent of formal examinations to some subjects. All were developed from the literature then subjected to tests of validity, reliability and sensitivity as described in the following sections.

### Theoretical Microbiology

The Principles of Microbiology Questionnaire was developed for the study as the only existing instrument by *Williams and Buckles (1988)* was judged to lack face validity on the grounds that several questions were more concerned with classical communicable diseases than HAI. No details of reliability or validity testing appear in the published article and there seems to be little effort to measure the sensitivity of individual items as a discrimination index is not provided.

**The Case Studies**

No method of assessing nurses' ability to apply knowledge of microbiology to patient care was found within the literature so the case studies were developed, presenting subjects with vignettes sufficiently general for the situations described to be possible in ITU, general medical or surgical wards. Case studies were employed because they simulate real-life situations and therefore have verisimilitude.

Questions were concerned with nurses' ability to draw on knowledge of microbiology and use it to make decisions directly concerned with patient care. This approach has been employed successfully by *Davitz and Davitz (1980)* and *Fothergill Bourbonnais and Wilson-Barnett (1992)* assessing nurses' ability to prioritise and provide appropriate care to the patient in pain. Each case study will be described in turn.

Case Study 1 investigated nurses' knowledge of blood and body fluid precautions. For Qr 5 no agreement could be reached as a policy for dealing with blood splashes to apparently intact skin did not exist in Hospital A, but the question was retained as it was felt this would yield valuable data on a vexed issue.

Case Study 2 was concerned with knowledge about contact precautions for MRSA. One question (Qr 11) was designed to assess opinion rather than knowledge but appeared on the questionnaire as this would appear more logical to subjects because it followed others on the same topic. Qr 5 and 11 were analysed in conjunction with the interview data.

After the data had been collected, a study by *Larson, Horan, Cooper et al, (1991)* was published using vignettes to establish how infection control nurses define nosocomial infections identified from routine surveillance data. The purpose of this study and its target population were quite different to the present study, but the authors were able to undertake considerable validity and reliability testing and examined levels of discrimination for individual questions. This provided added confidence in the use of vignettes to establish knowledge of infection control, particularly as standard textbooks provide little help concerning the validation of vignettes.

**Practical Ability**

Practical ability was assessed by a questionnaire adapted from *Linden (1990)*, The Knowledge of Hand Hygiene Appropriate when Performing Specific Nursing Procedures. This was presented last as it appeared less threatening to subjects (Qr 20 in the final knowledge questionnaire).

As with the observation schedule, extensive pre-pilot and pilot testing was necessary for each knowledge questionnaire.

**Pre-pilot Testing of the Knowledge Questionnaires**

At this early stage, aims were to:

1. Determine feasibility of the questionnaires in terms of length and the amount of time subjects could reasonably be expected to contribute.
2. To ensure that questions were clear, unambiguous, at the appropriate level and understood by subjects.
3. To establish content validity.

**Conducting Pre-pilot Testing of the Questionnaires**

Four groups of people were involved in pre-pilot testing:

1. An expert panel consisting of three experienced infection control nurses and an infection control officer with a particular interest in nurse education were asked to comment on content validity. Two of the nurses had written about hand decontamination and one had conducted research in this area.
2. The infection control policy in Hospital A was scrutinised and in those few cases where no provision was made for topics covered in the questionnaires (issues concerned with glove wearing and blood splashing onto intact skin) clarification of what to consider appropriate was sought from the infection control nurse and occupational health doctor in Hospital A.
3. Twenty-one undergraduate nurses about to qualify were asked to comment on format and individual questions as they completed each questionnaire. They were approached because they had received considerable microbiology teaching (30 hours) during their course.
4. Six nurses from the pre-pilot ward completed and commented on the questionnaires.

**Results of the Pre-pilot Studies**

1. All members of the expert panel responded favourably. They believed that the information tested by the questionnaires was a reasonable reflection of what a clinical nurse could be expected to know. From this it was anticipated that the questionnaires had content validity, but this remains open to doubt, as discussed later.

2. The infection control nurse was able to provide additional information on the policies in Hospital A, but confusion continued over the correct action which should be followed if intact skin became splashed with blood.
3. The undergraduates completed the questionnaires under the researcher's supervision, made individual comments and discussed their overall reactions as a group. They considered the case studies interesting and thought-provoking but time consuming (average completion thirty minutes). Despite over thirty hours of microbiology teaching during their course, a few questions on the 'Principles of Microbiology' could be tackled by no-one.
4. Staff on the pre-pilot ward commented on the clarity of the questions, which indicated they had face validity, but found them time-consuming (average completion forty minutes). This was apparently because they were anxious about displaying lack of knowledge, and needed excessive time to answer all questions fully.

**Changes to the Questionnaires from the Pre-pilot Studies**

1. Changes were made to a few statements on the questionnaires to improve clarity, but these were slight. The main changes were intended to reduce subjects' anxiety and the amount of time needed for completion.
2. Four difficult questions which no-one had attempted and which were therefore not discriminating were removed from the Principles of Microbiology Questionnaire.

3. The case studies were condensed, removing a few questions intended as reliability checks which produced overlapping information. A major effort was made to reduce the amount of time spent writing.
4. The overall format of the questionnaires was altered. They were subsumed into one continuous form, opening with the case studies because they appeared less threatening. Questions from the Principles of Microbiology followed, then the Knowledge of Hand Hygiene for Specific Nursing Procedures, as this was found easier by most nurses and provided a satisfactory conclusion.

**Pilot Testing the Questionnaires**

The questionnaires in their new format were tested on twelve nurses in one of the pilot wards (B). Completion under supervision took 15-25 minutes. No adverse comments about length were made and no problems with the wording of questions or format were encountered.

Repeated testing of the questionnaires throughout Pilot Study 1 and 2 had been planned to allow statistical tests of reliability and validity to be performed. This proved impossible because of the very low rate of return of questionnaires on the pilot study wards, an unanticipated problem as staff had appeared positive towards the research. Some loss of data was inevitable, as three nurses left the hospital within a few days, one had personal problems involving sudden compassionate leave and another began maternity leave early.

Statistical tests of reliability and validity were therefore conducted with the main study sample but will be described here, following an account of response rate.

**Obtaining Data Concerned with Knowledge**

In the main study the questionnaires were presented after observation and interview to allow rapport to develop between researcher and subject and to maximise response rate. Owing to the pressure of clinical work, completion inevitably took place away from the ward, unsupervised by the data collectors. Where questionnaires were not returned within an agreed period (one week) the ward was visited to issue verbal reminders. Postal reminders were necessary in Hospital B.

Questionnaire format appeared acceptable to the nurses, but as in the pilot studies, they commented on the thought-provoking nature of some questions. There was no evidence that they failed to understand written instructions. Remarks were frequently made concerning the amount of time required for completion.

**Response Rate of the Knowledge Questionnaires**

**TABLE 5.12 Response Rate of the Knowledge Questionnaires**

| | A | | B | | Both Hospitals | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| ITU | 27 | 90 | 23 | 76.66 | 50 | 83.33 |
| Surgical | 29 | 96.66 | 19 | 63.33 | 48 | 80 |
| Medical | 24 | 88.88 | 8 | 30.78 | 32 | 60.37 |
| | 80 | 91.95 | 50 | 58.13 | 130 | 75.14 |

Overall one hundred and thirty (75.14%) of the one hundred and seventy-three nurses observed completed Case Study 1 and Case Study 2. One hundred and twenty-nine completed the Principles of Microbiology and one hundred and twenty-eight the Knowledge of Hand Hygiene Related to Specific Nursing Procedures. Response rate was significantly greater in Hospital A and on ITU and surgical units (see Table 5.12).

$X^2 = 26.476 \quad 1df \quad p < 0.001$

$X^2 = 7.902 \quad 2df \quad p < 0.05$

The low response rate from medical wards is reflected chiefly in Hospital B, where only three questionnaires were returned from Ward 12 and none from Ward 13. Other variables examined for their influence are discussed in Chapter Six.

**Scoring the Knowledge Questionnaires**

Each question was intended to assess knowledge of some different aspect of infection control, but as the relative importance of each was unknown, all were scored out of the same total (4). Quantitative scores were keyed directly into the computer. Responses to open-ended questions were first subject to content analysis according to the answer guide shown in Appendix Three. A score of 0-4 was given according to accuracy and completeness. "Textbook" answers were not expected as this was not a formal examination. The results of validating and reliability testing also affected the final format of the knowledge questionnaires as explained in the following sections.

### Validity and Reliability of the Knowledge Questionnaires

*Carmines and Zeller (1979)* distinguish between the following types of validity : criterion, construct and content validity. Each is considered in turn below.

### Criterion Validity

According to *Nunnally (1978)* criterion validity is at issue when the study is concerned with the use of an instrument intended to assess some facet of behaviour external to the measuring instrument itself. This external measurement constitutes the criterion. The degree of concordance between the instrument in question and the criterion can be estimated by the extent to which their quantified results correlate. A distinction is made between concurrent and predictive construct validity, dependent on whether testing is possible currently or in the future.

The Case Studies and Knowledge of Hand Hygiene for Specific Nursing Procedures were intended to assess how nurses used knowledge to prevent infection in hypothetical but realistic situations, while the Principles of Microbiology was intended to measure knowledge of those theoretical aspects of medical microbiology underpinning clinical nursing practice.

The external criterion was the observed behaviour of the same subjects in the clinical environment. One of the main aims of the study was to develop a suitable method of directly observing this behaviour ~~and use it to compare nursing practice in different clinical setti~~

the degree of concordance between the results of the knowledge questionnaires and observation would rest as much on the validity of the observation schedule as the questionnaires.

This dichotomy is acknowledged by *Carmines and Zeller (1979)*, who advocate that whenever possible independent evidence of the validity of the criterion should be derived. No other estimate of the validity of the observation schedule was available. However, this was not considered an insurmountable problem owing to the relatively measurable and tangible nature of the observation data compared to the highly abstract constructs so often measured by social scientists (*Kleinbaum and Kupper, 1978*). It could therefore be argued that if the results of the knowledge questionnaires correlated strongly with those aspects of observed behaviour they were designed to test, criterion validity would be established. Alternatively, lack of concordance could mean that despite sound knowledge, other difficulties prevented clinical implementation, as discussed in the literature review. The relationship between the questionnaire and observation data is discussed in AIM 6 of the results.

Construct Validity

Construct validity is concerned with the extent to which the result of a given instrument concords with other measures consistent with theoretically derived hypotheses relating to those constructs which are being examined (*Carmines and Zeller, 1979*). According to *Cronbach and Meehl (1955)* construct validity is central to the measurement of abstract theoretical concepts and is possible only when there is an established theoretical network surrounding the concept and other measures to quantify it exist. Despite attempts of other authors to establish how health care professionals relate knowledge to clinical practice, their methods of assessment were not sufficiently rigorous to be considered suitable measures against which to rate the validity of the knowledge questionnaires.

*Carmines and Zeller (1979)*, commenting on the use of factor analysis to establish the value of empirical measures, emphasise that results are more likely to be misleading than helpful if they are interpreted without theoretical guidance.

The tangible nature of knowledge relating to infection control compared to highly abstract concepts is unarguable, so a decision was taken to accept the results of the knowledge questionnaires at face value without subjecting them to the lengthy and time-consuming process of factor analysis, a decision reached with the statistician advising the study. However, an attempt was made to ensure that all the questions on each of the case studies and Principles of Microbiology were measuring the same construct. To test this, overall raw scores were calculated for each questionnaire as a whole then correlated with scores for individual questions, as recommended by *Oppenheim (1966)*. Spearman's Rank Correlation Coefficient was employed. Choice of statistical tests is discussed in the final section of this Chapter.

The results are presented below:

**Total score for Case Study I (blood and body fluid precautions) correlated with scores for individual questions.**

| | | | | |
|---|---|---|---|---|
| **$n$ = 130** | Total score and | qr 1 | $r_s = 0.398$ | $p < 0.005$ |
| | | qr 2a | $r_s = 0.432$ | $p < 0.005$ |
| | | qr 2b | $r_s = 0.594$ | $p < 0.005$ |
| | | qr 3 | $r_s = 0.282$ | $p < 0.005$ |
| | | qr 4 | $r_s = 0.264$ | $p < 0.005$ |
| | | qr 6 | $r_s = 0.488$ | $p = 0.005$ |
| | | qr 7 | $r_s = 0.475$ | $p = 0.005$ |

According to these results, there was strong correlation between each of the questions intended to assess knowledge of blood and body fluid precautions. All questions could be considered to measure the same construct.

**Total score for Case Study 2 (contact precautions) correlated with scores for individual questions.**

| | | | | |
|---|---|---|---|---|
| $n = 130$ | Total score and | qr 8 | $r_s = 0.233$ | $p < 0.01$ |
| | | qr 9 | $r_s = 0.478$ | $p < 0.005$ |
| | | qr 10a | $r_s = 0.388$ | $p < 0.005$ |
| | | qr 10b | $r_s = 0.302$ | $p < 0.005$ |
| | | qr 10c | $r_s = 0.114$ | N.S. |
| | | qr 10d | $r_s = 0.380$ | $p < 0.005$ |
| | | qr 10e | $r_s = 0.157$ | N.S. |
| | | qr 10f | $r_s = 0.105$ | N.S. |
| | | qr 10g | $r_s = 0.318$ | $p < 0.005$ |
| | | qr 10h | $r_s = 0.411$ | $p < 0.005$ |
| | | qr 10i | $r_s = 0.243$ | $p < 0.01$ |
| | | qr 10j | $r_s = 0.546$ | $p < 0.005$ |
| | | qr 10k | $r_s = 0.495$ | $p < 0.005$ |
| | | qr 10l | $r_s = 0.389$ | $p < 0.005$ |
| | | qr 10m | $r_s = 0.164$ | N.S. |

According to these results the scores of four questions (concerned with handling infected waste, the use of single rooms for isolated patients, bathing in chlorhexidine and the use of one nurse per shift to care for an infected patient) did not correlate significantly with overall score and were therefore deleted, so that only the eleven remaining items were used in further statistical analysis.

**Total score for the Principles of Microbiology Questionnaire correlated with scores for individual questions:**

| | | | | |
|---|---|---|---|---|
| $n$ = **129** | Total score and | qr 12 | $r_s = 0.221$ | $p < 0.05$ |
| | | qr 13a | $r_s = 0.452$ | $p < 0.005$ |
| | | qr 13b | $r_s = 0.215$ | $p < 0.05$ |
| | | qr 14 | $r_s = 0.419$ | $p < 0.005$ |
| | | qr 15 | $r_s - 0.326$ | $p < 0.005$ |
| | | qr 16 | $r_s = 0.278$ | $p < 0.005$ |
| | | qr 17 | $r_s = 0.453$ | $p < 0.005$ |
| | | qr 18 | $r_s = 0.330$ | $p < 0.005$ |
| | | qr 19a | $r = 0.670$ | $p < 0.005$ |
| | | qr 19b | $r = 0.609$ | $p < 0.005$ |

The scores of each question correlated with the total score, so all questions were retained as they were apparently measuring the same phenomenon.

### Content Validity

Content validity has been defined as "Acceptance of the universe of the content defining the variable to be measured" (*Cronbach and Meehl, 1955 p. 282*). Content validity has played a major role in the development of educational tests, but is not held in such high regard as statistical measures of validity by these authors because of the difficulty deciding the full domain of content and sampling all relevant material randomly for inclusion. *Carmines and Zeller (1979)* point out that achieving content validity becomes more difficult when abstract concepts are examined. Despite the reservations of these authors, content validity was considered important for the knowledge questionnaires and reasonably achievable because the concepts were concrete rather than abstract.

The questionnaires were seen and commented upon by experts outside and within the hospitals included in the study during pre-pilot work as previously described. However, in retrospect, it became apparent that none of these people was in a position to state unequivocally that clinical nurses could and should be able to answer all the questions.

**Item Analysis**

One method of validating an educational test is to examine how difficult or easy the individual questions are, providing an estimate of discrimination (*Quinn, 1980*). *Fothergill-Bourbonnais (1990)* and *Larson, Horan, Cooper et al (1991)* calculated the *p* level, defined as the proportion of correct responses to a particular question. The closer the *p* level is to 1.00 the easier the question, while a *p* level approaching 0 indicates difficulty. *p* levels of between 0.30 to 0.70 are considered desirable.

A problem not acknowledged by either *Fothergill-Bourbonnais (1990)* or *Larson's* team (1991) is that their tests constitute knowledge assessment of practising nurses: they are not formal educational tests; neither were the knowledge questionnaires used in this study. Owing to tentative evidence of content analysis, the acceptance of a particular *p* level as a valuable indicator of validity must also be tentative. However, item analysis was considered a worthwhile exercise to help determine the usefulness of the knowledge questionnaires administered to clinical, non-specialist nurses. Before this could be undertaken, a second problem had to be addressed.

Some questions on the Case Studies and Principles of Microbiology yielded qualitative material subjected to content analysis, scored according to accuracy and degree of comprehension. These questions do not lend themselves easily to item analysis. A decision was taken to consider a score "correct" if it showed sufficient understanding to allow safe practice, even if a maximal score was not awarded. The results of item analysis are presented below

**Item Analysis (*p* levels)**

**Case Study I (blood and body fluid precautions)**

$n = 130$

*qr 1* — *Precautions which should be taken when handling blood and body fluids*

A score of 1 was awarded for every correct nursing action mentioned up to a maximum of 4. To achieve safety nurses had to mention glove-wearing and hand decontamination.

$p = 95/130 = 0.730$

*qr 2a* — *Concept of carriage for the HBV antigen*

| | | | |
|---|---|---|---|
| Limited grasp of concept | = | 2 | acceptable |
| Full understanding | = | 4 | |

$p = 114/130 = 0.876$

*qr 2b* — *Knowledge that blood/body fluid precautions should be universal irrespective of known HBV carrier status*

Correct = 4

$p = 78/130 = 0.600$

*qr 3* *HIV precautions*

Correct = 4

$p$ = 125/130 = 0.961

*qr 4* *Safe action after sustaining a needlestick injury*

A score of 1 was awarded for every appropriate action up to a maximum of 4. A score of 3 was considered safe providing it included reporting the incident to the correct authority.

$p$ = 97/130 = 0.746

*qr 6* *Recognising risks of urinary tract infection for a patient catheterised long term (more than 3 days)*

A score of 4 was given to subjects able to indicate on the visual analogue scale that the patient was at high risk of developing a urinary tract infection.

$p$ = 69/130 = 0.5307

*qr 7* *Concept of bacterial antibiotic resistance*

Limited comprehension = 4 acceptable

Full understanding = 2

$p$ = 113/130 = 0.869

$p$ levels for Qr1, 2b, 4 and 6 could be considered acceptable. Qr 2a, 3 and 7 were too easy to be discriminating, but were considered worth retaining in view of evidence that HBV and HIV precautions are still not adequately understood by nurses (*Ho-Yen et al, 1985; Searle, 1987*).

**Case Study 2 (contact spread)**

**qr 8 Comprehension of threats posed by MRSA.**

Limited knowledge = 2
adequate
Full knowledge = 4

$p$ = 112/130 = 0.8615

*qr 9 Route of transmission for MRSA*

Subjects were given a score of 4 if they selected the correct response from the list provided.

$p$ = 71/130 = 0.5415

*qr 10a Value of gloves preventing spread of MRSA*

Correct = score 4

$p$ = 105/130 = 0.8076

*qr 10b Value of handwashing in control of MRSA*

Correct = score 4

$p$ = 121/130 = 0.9307

*qr 10c Value of "double-bagging" linen to control spread of MRSA*

Correct = score 4

$p$ = 9/130 = 0.0692

*qr 10d Value of single room with the door open to reduce sp of MRSA*

Correct = score 4

$p$ = 31/130 = 0.2384

| | | | |
|---|---|---|---|
| *qr 10e* | ***Value of single room with the door shut in limiting spread of MRSA*** | | |
| | Correct | = | score 4 |
| | $p$ = 14/130 | = | 0.1076 |
| *qr 10f* | ***Value of bathing the patient in chlorhexidine to reduce spread of MRSA*** | | |
| | Correct | = | score 4 |
| | $p$ = 27/130 | = | 0.2076 |
| *qr 10g* | ***Value of a mask to limit spread of MRSA*** | | |
| | Correct | = | score 4 |
| | $p$ = 36/130 | = | 0.2769 |
| *qr 10i* | ***Wearing a plastic disposable apron to limit spread of MRSA*** | | |
| | Correct | = | score 4 |
| | $p$ = 88/130 | = | 0.6769 |
| *qr 10j* | ***Wearing overshoes to limit spread of MRSA*** | | |
| | $p$ = 72/130 | = | 0.5538 |
| *qr 10k* | ***Value of haircovering in preventing spread of MRSA*** | | |
| | Correct | = | score 4 |
| | $p$ = 86/130 | = | 0.6615 |

*qr 10l* *Value of disposable crockery and cutlery in limiting spread of MRSA*

Correct = score 4

$p$ = 38/130 = 0.2923

*qr 10m* *Value of one nurse per shift solely responsible for infected patients in limiting spread of MRSA*

$p$ = 113/130 = 0.8692

According to these results Qr 9, 10i, 10j, 10k & 10l were ideal for assessing knowledge about contact spread. Qr 8, 10a, 10b and 10m were too easy while Qr 10f and 10g were too difficult. Qr 10c, 10e, 10f and 10m had already been discarded because they did not correlate with the total score for the questionnaire. The other questions were retained because they correlated and the test including them demonstrated split half reliability (see p193.

**Principles of Microbiology**

***n*** **= 129**

*qr 12* *Ability to name nosocomial pathogens*

A score of 1 was awarded for every correct response up to a maximal score of 4. Some latitude was necessary in the interpretation of results. For example, on Ward 4 (limb and vascular surgery) Clostridium would be considered a nosocomial pathogen, but not on a ward where this type of surgery was never performed. A score of 3 or 4 was necessary for this question, as two pathogens were actually named in the text.

$p$ = 41/130 = 0.3153

*qr 13a* *Transmission of Micro-organisms*

A score of 1 was given for every correct entry up to a maximum of 4. "Poor handwashing" was given a score only if "contact" was not suggested.

A score of 2 was considered adequate, providing the contact route was indicated.

$p$ = 84/129 = 0.6511

*qr 13b* *Identifying the chief mode of transmission for bacteria in hospital*

Correct = score 4

$p$ = 83/129 = 0.6434

*qr 14* *Identifying portals of entry*

A score of 1 was awarded for every correct entry up to a maximal score of 4. A score of 3 or more was considered adequate, providing it contained some indication of the role of invasive devices.

$p$ = 55/120 = 0.4263

*qr 15* *Identifying types of patients particularly susceptible to infection*

A score of 1 was given for every correct entry up to a maximal score of 4. A score of 3 or above was considered adequate.

$p$ = 78/129 = 0.6046

*qr 16* *Ranking HAI in order of most frequent occurrence*

Correct = score 4

$p = 21/129 = 0.1627$

*qr 17* *Distinction between the concepts of colonisation (carriage) and infection*

Limited comprehension = 2

adequate

Full understanding = 4

$p = 60/129 = 0.4651$

*qr 18* *Distinction between Gram negative and Gram positive bacteria*

Limited comprehension = 2

adequate

Full understanding = 4

$p = 50/129 = 0.3875$

*qr 19a* *Recognising which body fluids may transmit HIV*

A list of five body fluids was presented and a score of 4 awarded for each correct response. Three correct answers was considered a reasonable level of knowledge.

$p = 78/129 = 0.6046$

*qr 19b* *Recognising which body fluids may transmit HBV*

A list of body fluids was presented and a score of 4 awarded for each correct response. Three correct responses was considered a reasonable level of knowledge.

$p = 26/129 = 0.2015$

According to these results, an ideal level of discrimination was achieved by all the questions except Qr 16 and Qr 19b, which were too difficult. However, these were retained as the questionnaire as a whole had split half reliability (demonstrated below) and all the questions correlated positively with the total score.

**Reliability**

Reliability is concerned with the extent to which a measuring device yields the same results on different occasions (*Noll 1965; Polit and Hungler 1987*). Four different methods of assessing reliability are recognised (*Carmines and Zeller, 1979*). The test-retest and alternative forms methods (see *Nunnally, 1978*) were beyond the scope of this study, but it was possible to estimate split half reliability which was achieved for two of the three questionnaires:-

| | | | |
|---|---|---|---|
| Principles of Microbiology | $r_s = 0.453$ | $p < 0.005$ | $n = 129$ |
| Case Study 1 | $r_s = 0.114$ | N.S. | $n = 130$ |
| Case Study 2 | $r_s = 0.378$ | $p < 0.005$ | $n = 130$ |

**Internal Consistency**

The decision to use odd and even items to establish split half reliability is arbitrary. In a situation where items are not intended to become progressively more difficult, the first and second parts of a test might logically be compared. This problem may be overcome by computing Cronbach's alpha as a measure of internal consistency. The value of Cronbach's alpha increases with the number of items in the test, providing of course that all correlate (*Carmines and Zeller, 1979*).

This has resulted in the often quoted statement that reliability is enhanced by length (*Noll, 1965 p 87; Polit and Hungler, 1989*). Ambiguity in test items affects reliability (*Noll, 1965*), but this was reduced by careful piloting to achieve clarity. However results for Cronbach's alpha for all the questionnaires fell short of the ideal quoted by Carmines and Zeller (0.8-1).

| | | |
|---|---|---|
| Case Study 1 | = | 0.3532 |
| Case Study 2 | = | 0.5106 |
| Principles of Microbiology | = | 0.5210 |

Internal consistency was therefore not achieved.

**The Relationship of Knowledge Questionnaire Scores to One Another**

The questionnaires were designed such that Case Study 1 examined knowledge of blood and body fluid precautions while Case Study 2 investigated knowledge of transmission by the contact route exemplified by MRSA, outbreaks of which were known to have occurred in both hospitals. The Principles of Microbiology examined knowledge of theoretical principles which infection control experts use when developing guidelines for prevention. The Knowledge of Hand Hygiene for Specific Nursing Procedures looked at practical precautions. All these questionnaires were developed from the literature and as the need to add or delete questions could not be anticipated no attempt was initially made to ensure that each contained an equal number of questions. It was intended to correlate the overall scores of each. If correlation existed then a single overall score could be used in analysis.

However, this was not possible as the overall scores did not correlate in each case when the Spearman Rank Correlation Coefficient was applied:-

Case Study 1 and Case Study 2

$r_s = 0.070$ NS $n = 130$

Case Study 1 and Principles of Microbiology

$r_s = 0.267$ $p < 0.005$ $n = 129$

Case Study 2 and Principles of Microbiology

$r_s = 0.231$ $p < 0.05$ $n = 129$

Knowledge of Hand Hygiene and Specific Nursing Procedures and Case Study 1

$r_s = 0.075$ NS $n = 128$

Knowledge of Hand Hygiene and Specific Nursing Procedures and Case Study 2

$r_s = 0.030$ NS $n = 128$

Knowledge of Hand Hygiene and Specific Nursing Procedures and Principles of Microbiology

$r_s = 0.066$ NS $n = 128$

According to these results there was an association between knowledge of blood/body fluid precautions and the Principles of Microbiology and between knowledge of contact precautions and the Principles of Microbiology. This suggests that understanding theoretical principles is related to problems directly associated with patient care. However, knowledge of the two types of precautions were not related. Moreover, the Knowledge of Hand Hygiene for Specific Nursing Procedures scores failed to correlate with any of the other scores. This suggests that knowing about practical, everyday aspects of hand hygiene is unrelated to grasp of theoretical concepts.

It was decided to treat each of the four questionnaires independently during analysis but to further explore the relationship between individual questions from Case Study 1 and 2 with total score from the Principles of Microbiology to determine which questions were accounting for the correlation.

**Principles of Microbiology & :-**

| | | | |
|---|---|---|---|
| qr 1 | $r_s$ = 0.140 | N.S. | $n$ = 129 |
| qr 2a | $r_s$ = 0.210 | $p$ <0.05 | |
| qr 2b | $r_s$ = 0.052 | N.S. | |
| qr 3 | $r_s$ = -0.066 | N.S. | |
| qr 4 | $r_s$ = 0.117 | N.S. | |
| qr 6 | $r_s$ = 0.060 | N.S. | |
| qr 7 | $r_s$ = 0.321 | $p$ <0.005 | |

Only two questions from Case Study 1 correlated significantly with overall score for the Principles of Microbiology. These questions were concerned with the meaning of carrier status for HBV and the concept of antibiotic resistance.

**Principles of Microbiology & :-**

| | | | |
|---|---|---|---|
| qr 8 | $r_s$ = 0.308 | $p$ <0.005 | $n$ = 129 |
| qr 9 | $r_s$ = 0.180 | $p$ <0.05 | |
| qr 10a | $r_s$ = 0.089 | N.S. | |
| qr 10b | $r_s$ = 0.009 | N.S. | |
| qr 10d | $r_s$ = 0.191 | $p$ <0.05 | |
| qr 10g | $r_s$ = 0.102 | N.S. | |
| qr 10h | $r_s$ = 0.026 | N.S. | |
| qr 10i | $r_s$ = -0.192 | $p$ <0.05 | |
| qr 10j | $r_s$ = 0.107 | N.S. | |
| qr 10k | $r_s$ = 0.196 | $p$ <0.05 | |
| qr 10l | $r_s$ = 0.010 | N.S. | |

Five questions concerned with contact precautions correlated with total score for the Principles of Microbiology. In four cases positive correlation occurred, indicating that nurses who scored highly on individual questions also scored highly with theoretical concepts.

The four questions established why MRSA is considered such a problem in hospitals, its mode of spread, the best method of isolating infected patients and the value of hair covering when attending patients. A negative correlation was obtained for the need to wear gloves; thus nurses who scored well on this item scored poorly overall with the Principles of Microbiology, a finding which is unexpected and difficult to interpret.

The next step in detailed scrutiny of the questionnaires involved selecting specific questions from the Principles of Microbiology and correlating them with overall scores from Case Studies 1 and 2. Questions selected were those which logically could be expected to show a degree of association.

**Total score for Case Study 1 and:**

| | | |
|---|---|---|
| qr 13a | $r_s$ = 0.129 N.S. | $n = 129$ |
| qr 14 | $r_s$ = 0.201 $p$ <0.05 | |
| qr 17 | $r_s$ = 0.178 $p$ <0.05 | |
| qr 19a | $r_s$ = 0.252 $p$ <0.01 | |
| qr 19b | $r_s$ = -0.036 N.S. | |

According to these results, significant correlation existed between overall knowledge of blood/body fluid precautions and scores for questions concerned with how micro-organisms gain access to the internal tissues, the concept of carriage and which body fluids transmit HIV. No correlation existed between knowledge of precautions and the main ways micro-organisms are transmitted in hospital or which body fluids transmit HBV. It thus appears that understanding some, but not all the concepts examined in the Principles of Microbiology Questionnaire relate to nurses' ability to solve clinical problems.

**Total score for Case Study 2 and:**

| | | | |
|---|---|---|---|
| qr 12 | $r_s$ = 0.001 | N.S. | $n = 129$ |
| qr 13a | $r_s$ = 0.087 | N.S. | |
| qr 13b | $r_s$ = 0.044 | N.S. | |
| qr 14 | $r_s$ = 0.164 | N.S. | |
| qr 15 | $r_s$ = 0.055 | N.S. | |
| qr 16 | $r_s$ = 0.087 | N.S. | |
| qr 17 | $r_s$ = 0.249 | $p < 0.05$ | |
| qr 18 | $r_s$ = 0.167 | $p < 0.05$ | |

From these results only two questions from the Principles of Microbiology correlated with overall scores for contact precautions. These were the concept of carriage and the gram staining reaction. A further question, concerned with how micro-organisms gain access to the internal tissues (Qr 14) just missed significance. According to these ~~results, comprehension of theoretical principles is more closel~~ associated with grasp of blood/body fluid precautions than contact precautions.

**Evaluation and Summary of the Knowledge Questionnaires**

Although lack of knowledge has been linked to poor compliance there is little indication within the literature of the nature or depth of information needed by clinical nurses except in relation to blood and body fluid precautions, while even for this topic there is some disagreement. When authors claim that more "knowledge" is needed or attempt to provide it, they appear to be referring, at least in part, to psychomotor skills. Under these circumstances the failure of existing questionnaires to satisfy the most fundamental requirements of validity is not surprising.

A considerable amount of effort was concerned with the development and testing of the knowledge questionnaires in this study. Each was assumed to have content validity, as all were developed from the considerable literature relating to the topic and the expert panel agreed that clinical nurses should be able to answer the questions. However this was not borne out by the results.

Nurses' difficulty did not relate to the wording of the questionnaires, as pre-pilot subjects commented on their clarity, but the style of the questions and the way they were scored could have influenced results. A high proportion of the questions were open-ended, with scores awarded for completeness as well as accuracy. Pilot subjects commented on the amount of time needed to complete the questionnaires: lack of completeness may therefore have reduced marks awarded as subjects in the main study may have felt unwilling to commit much time to them.

This was unavoidable as the length of the questionnaires had been reduced after piloting and the omission of further questions would have prevented exploring all the issues necessary.

However, some questions required only ticking or one word responses, so lack of time is not the whole story, particularly as some questions in this style were poorly answered (for example Qr 19a). Another difference between pilot and main studies was allowing subjects to complete questionnaires in their own time. This was inevitable given the lack of time on busy wards, but not considered problematic as many of the questions were too "applied" to specific situations portrayed in the vignettes to allow cheating from books. Accuracy remains a problem because responses to some questions were couched in such vague terms they were meaningless, even though no attempt to " mark" them to the same standard demanded in a formal examination was made.

Whether or not subjects would have fared better if faced with the same material in a genuine examination rather than to comply with the request of a researcher with no authority is unknown. This absence of authority has not been commented upon by other authors eliciting knowledge (*Fothergill-Bourbonnais, 1990*).

A second phenomenon affecting results remarked upon by *Kelsey (1992)* was not problematic here. In *Kelsey's* study concerned with knowledge of HBV, subjects frequently left responses blank: whether this was through lack of knowledge or interest never became apparent.

In this study, subjects were requested to leave questions they could not answer unmarked, but in most cases at least some attempt was made, so that although response rate was disappointingly low (58.13%) in Hospital B, of those questionnaires returned, all were useable.

In their final form, the results of individual questions on each of the case studies and Principles of Microbiology correlated with the overall score for that questionnaire, indicating that each was measuring the same construct. The Knowledge of Hand Hygiene for Specific Nursing Procedures was not open to statistical analysis in this way. Split half reliability was achieved for Case Study 2 and the Principles of Microbiology, though not for Case Study 1.

Vignettes appeared a satisfactory and interesting means of obtaining clinically relevant data, as discussed by *Davitz and Davitz (1980)* and *Fothergill and Bourbonnais (1990)*, but at this juncture it is necessary to return again to the issue of content validity, which for vignettes has never received much attention.

The support of experts was enlisted in this study in an attempt to establish it. This appears to have been only partially successful, as the experts over-estimated subjects' knowledge to a considerable degree. The drawback of heavy reliance on content validity pointed out by *Crohnbach and Meehl (1955)* is therefore acknowledged: the degree to which it has been achieved can never be established in absolute terms because no-one is in the position of stating unequivocally what the entire realm of content should encompass.

A second drawback of assessing knowledge for research rather than educational purposes involves the decision to use a discrimination index to determine how difficult individual test items prove, in an attempt to establish reliability. This approach has been discussed by *Bourbonnais-Fothergill (1990).*

*Larson et al (1991)* calculated *p* levels as the proportion of subjects responding correctly to individual test items. *p* levels were considered ideal if they fell between 0.3 and 0.7. Discrimination indices are not designed for use with open-ended questions, so responses falling into this category were coded as "correct", if they displayed adequate, though not necessarily ideal levels of knowledge.

According to *Larson's* criteria five questions from Case Study 1 were discriminating and two (Qr2a and 3) were too easy, although they were retained for final analysis because the aim of the research was to examine knowledge which might be reflected in clinical expertise, not formal assessment under examination conditions. Qr2a was concerned with the concept of carriage for the HBV antigen. Subjects expressed ideas rather vaguely, so possibly too much latitude was allowed when scoring this question, as knowledge assessed with the same question by *Kelsey (1992)* did not appear to be particularly good. Qr 3 was more problematic, as it required subjects to indicate whether they would employ the same tactics to reduce risks of HIV as they would for HBV. The majority indicated, appropriately, that they would take the same ~~action, but on the evidence of Qr1, which invited them to state t~~ precautions necessary when handling blood and body fluids generally, knowledge was less good for all subjects, so the validity of Qr3 is in doubt.

This illustrates the pitfalls of questionnaire construction reported by experts (*Oppenheim, 1966*) as well as the problems inherent in the development of objective tests (*Cheveney, 1988; Farley, 1989*). These are particularly fraught when applied rather than theoretical knowledge is assessed.

Only two questions on the Principles of Microbiology lacked ideal discrimination indices compared to five of those used in final analysis from Case Study 2. Qr8, the opening question, was too easy, but it had been designed to gain subjects' confidence by proving within their capacity. The remaining items were also too easy, but from the clinician's view point this would be desirable, as they were designed to elicit information about routine procedures which should be within the capacity of every nurse.

Whether or not the discrimination index is a meaningful way of validating tests for use outside the examination hall therefore remains open to debate, although they may be of value when standard tests are used to compare the knowledge of different groups.

Overall it may be concluded that the questionnaires proved satisfactory though not ideal for their purpose in this study.

**Opinions and views about HAI and infection control**

Nurses' views of HAI and infection control were examined by a Likert Scale and an interview intended to obtain complementary information rather than to operate as direct checks of each other's reliability and validity. Each is described below.

**The Likert Scale**

In the spring of 1991 when the study was designed, only one published article concerned with the systematic assessment of the opinions of hospital staff towards hand decontamination could be found. Doctors and nurses were asked to report their own handwashing frequency and state factors which encouraged or discouraged handwashing (*Larson and Killien 1982*). The authors used decision-making theory. No questions on blood and body fluid precautions were included and no attempts to observe behaviour were made. *Linden (1990)* developed a Likert scale from this original instrument with added statements intended to elicit opinions about glove use and contact with blood and body fluids. The higher the score, the more favourable the attitude towards infection prevention. Linden's scale was adapted for the study throughout pilot work in the following ways:

1. Two statements were added from a more recent study concerned with attitudes and beliefs towards safe sharps disposal (Becker et al, 1990).
2. During pilot testing of the observation schedule it had been noted that nearly everyone wore at least one ring (in addition to a wedding band). In view of evidence that bacterial count is increased beneath rings (*Hoffman et al, 1985*) although the influence of this on infection rates has yet to be established (*Jacobson et al, 1985*), an item concerned with ring-wearing was added.
3. Several nurses mentioned in casual conversation that they were less inclined to wash hands between handling different parts of the same patient than between different patients because cross-infection would not occur.

A further item was added to the Likert scale:- "It is not necessary to wash hands between handling different parts of the same patient as cross-infection is not possible".

4. The scale was now becoming lengthy, so four items concerned with attitudes towards continuing education and HAI were removed as this topic would be covered during interview.

**Final Format of the Likert Scale**

The Likert Scale eventually consisted of twenty-two items arranged on a continuum: strongly agree, agree, undecided, disagree, strongly disagree. The use of an intermediate category has been questioned by experts in the field of attitude measurement (*Oppenheim, 1966*), but was retained as it was felt important that subjects should be able to express their views as fully as possible within the confines of the scale. Fifteen of the items were positively worded and seven negatively worded to overcome the problem of response set defined by *Carmines and Zeller (1979)* as the general tendency to respond to questionnaire items in a particular manner, irrespective of their content (*p. 65*).
This was a potential problem in a situation where a strong social desirability factor could also be operating. The scale would be scored as shown in Appendix Two, allowing results to be keyed directly into the computer.

**Pilot Testing**

The Likert Scale was administered to the same undergraduates who tested the knowledge questionnaires and sent to the same expert panel. It occasioned much more comment than the other questionnaires and changes were made to the wording of items on their advice.

The use of the Likert Scale to elicit opinions was clearly indicated, but at least one expert appeared to think that this scale was also intended to assess knowledge. No additional items were suggested for inclusion. The scale was completed by the same pilot subjects as those completing the knowledge questionnaires. This took five minutes. Its role in assessing opinions rather than factual information was emphasised.

**Validity and Reliability Testing**

Again, too few Likert Scales were returned during the pilot study for statistical tests of reliability and validity to be performed, so this was undertaken with the main sample.

**Criterion Validity**

No external concurrent criterion of nurses' opinions of infection control practice existed except for their observed behaviour documented by the observation schedule developed specifically for the study. The interview sought to establish opinions, but this was not intended to sample identical material. Thus, the criterion validity of the Likert Scale remains open to question.

**Construct Validity**

No independent construct validity measure of nurses' opinions of infection control apart from the original study by *Larson and Killien (1982)* existed until the publication of an article by *Zimacoff et al, (1992)* after the completion of data collection. This study, derived from the same original work by Larson and Killien, was concerned only with hand decontamination and not extensively tested for reliability and validity.

It was decided to compare the results of the Likert Scale to these studies and to comments made by authors in research reports about factors that might affect behaviour, although it was acknowledged that this was not a replacement for construct validity. However, to determine whether each of the twenty-two items were measuring aspects of the same phenomenon, the total score for each nurse was correlated with scores for each of the individual items as suggested by *Oppenheim (1966)*. The results presented below suggest that all but two items were measuring the same phenomenon.

Total score:- correlated with

| | | | |
|---|---|---|---|
| Q 1 | $r_s = 0.455$ | $p < 0.005$ | |
| 2 | $r_s = 0.224$ | $p < 0.05$ | |
| 3 | $r_s = 0.144$ | N.S. | (frequent handwashing makes your hands sore) |
| 4 | $r_s = 0.529$ | $p < 0.005$ | |
| 5 | $r_s = 0.425$ | $p < 0.005$ | |
| 6 | $r_s = 0.550$ | $p < 0.005$ | |
| 7 | $r_s = 0.531$ | $p < 0.005$ | |
| 8 | $r_s = 0.310$ | $p < 0.005$ | |
| 9 | $r_s = 0.215$ | $p < 0.05$ | |
| 10 | $r_s = 0.404$ | $p < 0.005$ | |
| 11 | $r_s = 0.343$ | $p < 0.005$ | |
| 12 | $r_s = 0.290$ | $p < 0.005$ | |
| 13 | $r_s = 0.425$ | $p < 0.005$ | |
| 14 | $r_s = 0.346$ | $p < 0.005$ | |
| 15 | $r_s = 0.408$ | $p < 0.005$ | |
| 16 | $r_s = 0.304$ | $p < 0.005$ | |
| 17 | $r_s = 0.240$ | $p < 0.01$ | |

| | | | | |
|---|---|---|---|---|
| 18 | $r_s$ = | 0.377 | $p$ <0.005 | |
| 19 | $r_s$ = | 0.373 | $p$ <0.005 | |
| 20 | $r_s$ = | 0.075 | N.S. | (gloves are worn to protect the nurse rather than the patient) |
| 21 | $r_s$ = | 0.207 | $p$ <0.05 | |
| 22 | $r_s$ = | 0.386 | $p$ <0.005 | |

The two items lacking correlation were predictable as they occasioned much written comment on the forms. They were deleted from the scale to leave twenty statements for use in further analysis.

### Content Validity

The infection control experts asked to comment on the study instruments found the Likert scale more problematic than the knowledge questionnaires. The wording of numerous items had to be changed and at least one expert remained under the misapprehension that this scale was intended to assess knowledge, although the accompanying information emphasised that this was not the case. Completion by nurses during the main study indicated further problems, judging by the number of unsolicited comments written on the forms. Content validity of this measure may therefore be questionable, especially as the literature from which it was originally drawn, attitudes towards HAI, has yet to become well established and a social desirability factor could be operating.

**Reliability**

Test-retest and alternative forms of reliability testing were beyond the scope of this study, but split half reliability of the twenty items was established :

$r_s$ = 0.364 $p$ <0.005 $n$ = 139

Cronbach's alpha = 0.6373

**The Interview**

Attitude scales have been used for many years (*Brewster-Smith 1966*), but some authorities believe that attitudes are too complex to measure on rigid scales requiring subjects only to mark off statements and that richer as well as more valid data may be obtained by asking them to express their feelings through open-ended questions, although these are more difficult and time-consuming to analyse (*Fielding, 1985; Corner, 1988*). As this was an exploratory study and the validity of the Likert Scale was unknown it was additionally decided to employ a short, semi-structured interview schedule consisting mainly of open-ended questions to obtain more detailed information.

The interview consisted of twelve questions designed to explore subjects' opinions on the prevalence of HAI, risks to themselves and their patients, opportunities to continue learning about infection control and to explore their perceptions of facilities available to help them prevent infection. A final section obtained socio-demographic data.

**Pilot testing the interview**

The interview was tested on qualified nurses on Ward B, Hospital A. The aims were to :

1. Determine any changes necessary to the existing questions.
2. Add more questions to cover areas which had been overlooked but which subjects regarded as important.
3. Determine the range of information likely to be available and how analysis should proceed.
4. Estimate the amount of time necessary for completion.

**Results of Pilot interviews (Pilot Study 1)**

Results will be discussed in terms of the aims.

1. No changes were necessary to the existing questions.
2. The first nurse to be interviewed commented that hand hygiene caused considerable discomfort. Skin problems are well-documented as detrimental to hand hygiene compliance (*Ojajarvi 1991; Larson and Killien, 1982*). It was therefore decided to incorporate a question concerning skin problems.
3. The interviews yielded a considerable amount of qualitative information amenable to content analysis, illuminating the main aims of the study.
4. On average each interview lasted 15-20 minutes.

A number of other points to emerge merited consideration:

1. A decision to document ring-wearing on the interview schedule ~~was made, as this was difficult to observe when gloves were~~ worn.

2. Comments made by staff concerning facilities available for infection prevention were particularly interesting and revealed that much could depend not only on availability of equipment but also on ward layout, as already discussed by *Broughall et al (1984) and Kaplan and McGuklin (1986)*, although this has been disputed in at least one study (*Preston et al, 1981*). This strengthened the decision to include wards of a similar design and to document ward facilities for the prevention of infection (e.g. number and location of sharps boxes, hand decontaminating agents) on a checklist to produce standard information for comparison between wards, the Ward Facilities Checklist.

**Ward Facilities Checklist**

During pilot studies it became apparent that supplies of equipment likely to affect infection control behaviour (type of hand decontaminating agent, gloves) were subject to variation.

Layout of the wards, particularly positioning of sinks, was also slightly different and, as this may have some influence on behaviour, a Ward Facilities Checklist was developed to collect this information in a structured manner so that variations could be compared systematically. The authors of only one other study comment on the variation of facilities within one hospital (*Larson, McGinley and Foglia, 1992*).

## Assessment of Levels of Ward Activity: Patient Dependency and Nursing Workload

### Patient Dependency

The decision to incorporate this measure, founded on a simple assessment of patient dependency, was based on an early impression gained during pilot work that levels of ward activity could vary considerably. This might alter nursing behaviour such as hand decontamination, but has largely been ignored by other authors, with the exception of *Doebbeling et al, (1992)*.

Over twenty years ago *Lowbury et al, (1970)*, identifying possible sources of gram negative infection in patients who had tracheostomies, declared that colonisation and infection probably reflected lapses in aseptic technique which might be due to pressures of work but produced no evidence to support this directly. *Taylor (1978)* claimed that levels of ward activity had no impact on handwashing behaviour, although she does not provide data to show how this activity was measured. *Haley and Bregman (1982)* are responsible for the only study designed to explicitly test the relationship between understaffing and infection rates. These authors, working in a neonatal unit, established that the incidence of clustered staphylococcal infections was sixteen times higher when the infant-nurse ratio exceeded seven and concluded that outbreaks periodically resulted when the unit was overcrowded and staffing levels declined, preventing scrupulous decontamination between infant contacts.

According to a definition derived from *Giovannetti (1984)* staffing levels are adequate when sufficient to provide the appropriate amount and type of nursing care to the largest group of patients for whom this is cost-effective, providing that it is consistent with desired nursing care outcomes and nursing satisfaction. It is usually expressed numerically [number of nursing hours/whole time nursing equivalents (WTE)] and assumes that the correct skill mix of staff has been achieved. Methodology for determining appropriate staffing levels has not changed much since the 1950's and is based on the premise that some patients require more care (physical, psychosocial or both) than others and that it is possible to assign all the patients on a ward to a weighted category such that their level of dependency directly influences the workload they create. Tracing the historical development of dependency classification systems, *Giovannetti (1984)* shows that several hundred have evolved in the USA varying mostly in superficial detail, chiefly in methods of documentation, paralleling the situation in the UK (*Wilson-Barnett, 1978*). Instruments developed to assess dependency and therefore patient classification inevitably rely on the ability of an experienced nurse to state how long a number of key indicators such as bathing or giving injections should take, with little evidence that a complex system incorporating a large number of different indicators is more likely to be valid. To achieve validity the system of categorisation must be assessed in each setting where it is to be employed and the figures given should agree with estimations provided by experienced nurses familiar with ward and patients (*Williams and Murphy, 1979*).

Validity is enhanced if a panel of expert nurses reach agreement and should be monitored periodically as changes affecting nursing practice such as the introduction of new technology or hospital policy can alter it.

Reliability of a patient dependency system refers to the consistency of outcomes determined by the classification process (*Giovannetti, 1984*). It could be threatened by differences in inter-rater reliability, but this can be overcome by an "expert" classifier of greater experience periodically checking the estimates of other nurses. Ninety percent agreement is arbitrarily taken as satisfactory while a level below 80% suggests a need for retraining. The indicators themselves should also be consistent: raters should use the same ones each time the measure is applied. The period of prediction afforded by a dependency measure varies with patient turnover: where throughput is great it must be applied more often.

A dependency measure developed by *Barr (1964)* was selected for the study because it is straightforward, easy to apply and thought to be as reliable as any other existing measure. According to this scheme every patient in the ward is graded as shown on Table 5.13 below.

**TABLE 5.13 Grading System for Patient Dependency**

(after *Barr, 1964)*

| | | |
|---|---|---|
| Group 1 | Self care | Score 1 |
| Group 2 | Intermediate care | Score 2 |
| Group 3 | Intensive care | Score 5 |

"Intensive care" refers to any patient who is unconscious, needing the care of his/her own nurse or receiving three or more of the following: naso-gastric feeding, intravenous fluids, suction, oxygen therapy or care of a large draining wound or stoma. A total score for the ward is calculated for direct comparison to results obtained from other wards and the same ward at different times.

**Workload**

The Dependency Scale discussed above provided a measure of the total level of ward activity, created by all the patients on the ward, shared among all the nurses. During observation the total number of clinical contacts made by each nurse was recorded, providing a measure of the individual nurse's level of activity. Both workload and dependency were employed in analysis because different regimes of ward organisation had been observed during fieldwork. In ITU each nurse was responsible for the care of only one or two patients, while on surgical and medical wards one nurse was always responsible for the care of a much larger group whether team or primary nursing was occurring. ITU nurses could have been more influenced by individual workload than dependency, but on surgical and medical wards the level of activity generated by the ward as a whole could be more influential, especially if the nurse was responsible for the supervision of students and junior colleagues.

By recording the number of clinical contacts, with high scores representing frequent nurse-patient interactions, opportunities to decontaminate hands would also increase.

This approach was taken by *Doebbeling et al (1992)*, who used the Unit Acruity Score in a comprehensive study of hand decontamination conducted in ITU. This score, as described in the published article, is a weighted classification system used routinely in the study hospital to assess ITU staffing requirements. The score was believed to reflect frequency of nurse-patient interactions because it was calculated according to the need of the patient for close monitoring, invasive devices and support equipment. It was therefore considered valid for the study even though not specifically developed for it.

Two methods of recording levels of ward activity were thus adopted for this study. Their usefulness is discussed in Chapter Six.

**The Possible Effect of Ward Atmosphere on Infection Control Practice**

During fieldwork in Hospital A striking differences in atmosphere between wards were noted by both data collectors and documented in fieldwork notes. The relationship between standards of nursing care and the morale of hospital staff has been acknowledged for many years (see *Revans, 1964*) and it has become accepted that ward climate is strongly influenced by the sister (see Chapter Three). Under these circumstances a decision was taken to document three variables which could affect standards of clinical practice: the priority which subjects believed infection control was awarded in their clinical setting; the learning environment provided for newly qualified staff and students and their own job satisfaction.

All subjects in Hospital B were asked to rate their opinions on Visual Analogue scales marked from 0-100%. Comparable data were not available from Hospital A.

The chapter concludes with an explanation of the approach to the analysis of the data presented in Chapter Six.

**Unit of Analysis**

The unit of analysis in this study was the nurse. This was consistent with the aims, which set out to examine the influence of knowledge, opinions, ward facilities and other variables on clinical practice. Initially it was intended to re-code and examine the data so that every nursing procedure (dressings, bed-making, endotracheal suction) were also employed as units of analysis. This approach was adopted by *Crow, Mulhall and Chapman (1988)* in a study of handwashing in relation to aspects of catheter care. When the data were recoded this approach was seen to be impractical here, not only because of the enormous volume, but also because individual nursing procedures had been broken down into component parts in order to record times throughout the same procedure when hand decontamination was necessary. A further difficulty was the need when employing procedure as the unit of analysis, to lift events out of context. This secondary analysis was therefore abandoned.

**Statistical Analysis**

The procedures undertaken with each method will be considered in turn.

**Observation**

The complex data were analysed in stages. During preliminary analysis, which took place as soon as possible after data collection, decisions were made concerning appropriateness of decontamination and choice of agent, all remaining components of practice were scored and results were keyed into the computer (see Appendix 4).

As observation was conducted in the intensive care, surgical and medical units of two hospitals the Analysis of Variance (ANOVA) was selected because it would permit simultaneous comparison of data from all six units. However, the design was unbalanced (e.g. there were missing data where some subjects failed to perform certain activities) inevitable in a fieldwork situation, so the test was performed using the Minitab command for the General Linear Model which is specifically intended for unbalanced designs. Two way tests were performed because this allowed the effects of hospital, clinical setting and their interaction to be examined simultaneously. The results of ANOVA only indicate if differences are significant, not their direction. This information was supplied by graphical representation of the data.

ANOVA operates by reducing each observed value into three additive components: an overall mean, deviation of each group mean from the overall mean and deviation of each observation from the group mean (*Iversen and Norpoth, 1987; Bryman and Cramer, 1990*). The difference between the observation and the mean for the group is taken to represent the effect of all the other variables (residuals) not included in the design. It is recommended that for valid use of the test variables should assume normal distribution (*Petrie, 1988*). However, according to *Iversen and Norpoth, 1987 - p 23*) "moderate" departures are acceptable because the test is robust and even when marked do not preclude use as the original data may be manipulated to assume normal distribution, although under these circumstances it is prudent to interpret results carefully. Before commencing analysis the raw data were examined for single extreme values which could skew distribution as recommended by these authors, and as this was seen to occur in a number of cases (e.g. use of agent), the advice of a statistician was sought.

It was concluded that use of ANOVA could be sanctioned without further manipulation.

Interval measurement is another requirement of ANOVA (*Petrie, 1988*). Some variables were undeniably at interval level in their original form (e.g. number of decontaminations, duration of handwashing) but for others converted into scores (e.g. choice of agent) this could be questioned. To ensure that results were not artefacts of the violation of the assumptions of ANOVA the data were also analysed using non-parametric tests. The Mann Whitney test was employed to compare data from two groups (hospitals) and the Kruskal Wallis test to compare data from three groups (units). Both are robust, approaching the same power as parametric tests (*Siegal and Castellan, 1988 - p 137*). They are suitable with ordinal data and do not require normal distribution. It was thus possible to compare results from ANOVA and non-parametric approaches. As shown in Chapter Six, discrepancy between results occurred in very few cases. The use of parametric tests therefore appeared justified, supporting the view of *Roberts (1989)* that non-parametric methods are often employed unnecessarily by nurse researchers. A further advantage of employing ANOVA to make simultaneous comparisons was that it was less likely that spurious differences would emerge. Moreover, additional variable (e.g. sociodemographic) could be introduced into the statistical model permitting further analysis.

Analysis was conducted with the mean results of observation as this would differentiate between good and poor practice more sharply than the median.

This was important as standard deviations for some facets of clinical practice (e.g. choice of agent) were small, demonstrating narrow variations in scores between individual nurses.

**Knowledge Questionnaires**

The same procedure was adopted as with the observation data to preserve uniformity. No discrepancies emerged when the results of ANOVA and non-parametric tests were compared.

**Likert Scores**

These constituted ordinal data so analysis with non-parametric tests was appropriate.

**Interview**

After content analysis each response was coded and keyed into the computer. Most of these data were nominal so the chi square test was employed. Examination of the Tables in Chapter Six reveals that insufficient data were available in some categories to permit analysis so where possible they were collapsed as recommended by *Bryman and Cramer (1990)*. Data generated by the visual analogue scales was regarded as ordinal.

**Ward Facilities Checklist**

These data were not sufficiently rigorous to permit statistical analysis.

**Use of Spearman's Rank Correlation Coefficient**

This was employed for all data whether ordinal or interval to achieve consistency. Spearman's Rank Coefficient Correlation is almost as effective as Pearson's Correlation Coefficient (*Siegal and Castellan, 1988 - p 244*). One tailed tests adjusted for ties were performed.

**Level of Significance**

The conventional 0.05 level was taken to indicate significance. However, this was regarded as modest: some tests revealed very highly significant findings ($p < 0.001$).

Results will be discussed in Chapter Six.

# CHAPTER SIX

## RESULTS

## BACKGROUND

Data for the main study were collected in Hospital A between July and November 1991 and in Hospital B between December 1991 and March 1992. In this section the method of recruiting subjects to the main study and the characteristics of the sample will be presented. Later sections present data in terms of the study aims. Each concludes with a summary briefly considering the success of each method in obtaining the required data because all were used for the first time in their existing form in this study. As large quantities of data resulted, the findings from each section are summarised for clarity.

### Obtaining the sample

When designing the study it was intended to secure the participation of ninety subjects in each hospital, so thirty nurses from each intensive care, surgical and medical unit would be represented. No selection of subjects would take place: all would be asked to participate until the target number was reached. As well as the two intensive care units, six wards in each hospital, three designated surgical and three medical, were approached with the intention of recruiting ten nurses from each. However, as indicated on Table 6.1, four medical wards (5, 7, 13, 14) lacked a full complement of nurses.

**TABLE 6.1 THE MAIN SAMPLE**

| WARD | N° | TOTAL | UNIT | N° | TOTAL | HOSPITAL | TOTAL |
|---|---|---|---|---|---|---|---|
| 1 | 30 | 30 | ITU | 30 | 30 | A | 87 |
| 2 | 10 | 10 | SURGICAL | 30 | 30 | | |
| 3 | 10 | 10 | | | | | |
| 4 | 10 | 10 | | | | | |
| 5 | 9 | 9 | MEDICAL | 27 | 27 | | |
| 6 | 10 | 10 | | | | | |
| 7 | *8 | 8 | | | | | |
| 8 | 30 | 30 | ITU | 30 | 30 | B | 86 |
| 9 | 10 | 10 | SURGICAL | 30 | 30 | | |
| 10 | 10 | 10 | | | | | |
| 11 | 10 | 10 | | | | | |
| 12 | 10 | 10 | MEDICAL | 26 | 26 | | |
| 13 | *8 | 8 | | | | | |
| 14 | *8 | 8 | | | | | |
| TOTALS | | | | | | | 173 |

* Ten nurses not available for recruitment

There was no attempt to make good the shortfall by including another ward as this would not have generated further information about the particular wards selected for the study.

Further exclusions occurred because two nurses, one on Ward 3 and one on Ward 12, refused to be observed. One nurse on Ward 5 absented herself whenever the researcher visited the ward. Apart from this, acceptance of the study was generally good until the very end of data collection when a staff nurse informed the researcher without explanation that she would deny her access to Ward 13 whenever she was on duty. As she was the only remaining nurse to be included, this ward was not visited again.

## Sociodemographic Data for the Main Study

Of the one hundred and seventy-three nurses included in the main study, eighty-seven (50.29%) were employed in Hospital A and eighty six (49.71%) in Hospital B. Sociodemographic data were obtained from all but one subject in Hospital A.

## Age

The youngest subjects were 21 years old and the oldest were over 50. Table 6.2 provides details of age, showing the majority to be less than 36 years ($n$ = 151, 88.82%).

**TABLE 6.2 AGE**

| AGE | HOSPITAL A | | HOSPITAL B | |
|---|---|---|---|---|
| | N° | % | N° | % |
| 21 - 25 | 27 | 31.76 | 34 | 40 |
| 26 - 30 | 31 | 36.48 | 40 | 47.06 |
| 31 - 35 | 13 | 15.29 | 6 | 7.05 |
| 36 + | 14 | 16.7 | 5 | 5.89 |
| **TOTALS** | **85** | | **85** | **2 subjects declined to give age** |

In Hospital A fourteen (16.47%) nurses were aged more than 35 years, compared to five (5.8%) in Hospital B. In ITU there were eleven nurses (18.6%) over 35 years, compared to two (3.3%) in surgical units and six (11.33%) in medical units.

### Gender

The sample included only thirteen (7.5%) men, distributed evenly between the two hospitals.

### Educational Qualifications

Eleven subjects (6.36%) had no GCSE or equivalent qualification, chiefly older, second level nurses. Eight (9.3%) were employed in Hospital A and three (3.49%) in Hospital B. One hundred and six subjects (61.63%) had 'A' levels, significantly more in Hospital B ($n$ = 64, 74.42%) than in Hospital A ($n$ = 42, 48.84%) $X^2$ 11.899 1$df$ $p$ <0.001. Twenty-nine (16.86%) were educated to degree level or reading a degree and fifteen (57.6%) had studied microbiology. There was no significant difference between the hospitals:- $X^2$ = 2.153 1$df$ N.S.
Twelve (20.33%) nurses in ITU were graduates compared to seven (11.66%) in surgical and ten (18.87%) in medical units. The largest number of graduates employed together occurred in ITU Hospital B ($n$ = 8) and Ward 12 ($n$ = 3).

### Professional Qualifications

### Registration

Most subjects ($n$ = 156, 90.17%) were first level (staff) nurses. In Hospital A seventy-one (81.16%) subjects were first level nurses. In Hospital B the only second level (enrolled) nurse included in the study was on Ward 13.

Table 6.3 illustrates that throughout Hospital A, the highest percentage of second level nurses was encountered on ITU.

**TABLE 6.3 Number of first and second level nurses employed in Hospital A: comparison of units**

| | FIRST LEVEL NURSES | | SECOND LEVEL NURSES | | TOTALS |
|---|---|---|---|---|---|
| | N° | % | N° | % | |
| ITU | 23 | 76.66 | 7 | 23.34 | 30 |
| Surgical | 26 | 86.66 | 4 | 13.34 | 30 |
| Medical | 23 | 85.18 | 4 | 14.82 | 27 |
| | 72 | | 15 | | 87 |

**Post basic qualifications**

Seventy-five (43.6%) nurses had taken an ENB certificate directly relevant to the clinical setting in which they were currently employed. There was no significant difference between the hospitals:- $X^2 = 1.518$ 1*df* N.S. However, ITU nurses were significantly more likely to hold a relevant postbasic qualification (see Table 6.4).

$X^2 = 66.489$ 2*df* $p < 0.001$.

**TABLE 6.4 Nurses holding a postbasic certificate: comparison of units**

| | HOSPITAL A | | HOSPITAL B | | TOTAL | |
|---|---|---|---|---|---|---|
| | N° | % | N° | % | N° | % |
| ITU | 25 | 83.33 | 26 | 86.66 | 51 | 86.44 |
| Surgical | 4 | 13.33 | 8 | 26.66 | 12 | 20 |
| Medical | 4 | 15.38 | 8 | 30.76 | 12 | 22.64 |
| | 33 | 38.37 | 42 | 48.83 | 75 | 43.60 |

The number of surgical and medical nurses holding an ENB certificate was unevenly distributed: four on Ward 13 and three on Ward 14.

## Professional Profile

### Number of Years Qualified

Length of time since qualification varied from a few days to nearly thirty years. Most nurses had been qualified for over three years (see Table 6.5).

**TABLE 6.5 Number of years qualified**

| | N° | % |
|---|---|---|
| Less than 1 year | 36 | 20.93 |
| 13 months - 3 years | 35 | 20.35 |
| More than 3 years | 101 | 58.72 |
| | 172 | |

Nurses in Hospital A were more likely to have been qualified for over three years than those in Hospital B:- $X^2 = 8.071$ $4df$ $p < 0.05$. Nurses employed in ITU were more likely to have been qualified over three years than those in medical or surgical wards:- $X^2 = 21.822$ $4df$ $p < 0.001$.

### Experienced and Less Experienced Nurses

One of the study aims was to determine whether experienced nurses held different beliefs concerning HAI, had different levels of knowledge or behaved differently from those who were less experienced. Experience was judged to exist after three or more years employment in the clinical setting (*see Benner, 1984*). A decision was taken to judge clinical experience separately from holding a relevant postbasic certificate because it was known that nurses in ITU were required to have experience within the speciality before they were eligible to begin the course.

Length of previous experience was increasing with demand for this popular course and conversation with post-basic tutors revealed that it was designed to provide theoretical input to those who already worked in ITU. Eighty (46.51%) of the nurses could be categorised as experienced, significantly more in Hospital A ($n$ = 49, 56.97%) compared to Hospital B ($n$ = 31, 36.04%) $X^2 = 7.572$ 1*df* $p$ <0.01. Table 6.6 suggests that ITU nurses were marginally more likely to be experienced than those in medical or surgical wards, but the result is not significant:- $X^2 = 3.353$ 2*df* N.S.

**TABLE 6.6 Number of experienced nurses: comparison between units**

| | HOSPITAL A | | HOSPITAL B | | TOTAL | |
|---|---|---|---|---|---|---|
| | N° | % | N° | % | N° | % |
| ITU | 18 | 60 | 14 | 46.66 | 32 | 53.33 |
| Surgical | 14 | 46.66 | 9 | 30 | 23 | 38.33 |
| Medical | 17 | 65.38 | 8 | 26.66 | 25 | 44.64 |
| | 49 | | 31 | | 80 | 46.51 |

On Wards 3, 6 and 7 in Hospital A, six experienced nurses were included in the study. On Wards 2, 5 and 14, four or five experienced nurses were included. For Wards 4, 9, 10 and 11 it was possible to include only three experienced nurses, while on Wards 12 and 13 only two experienced nurses were available.

The researchers did not suggest to ward staff that a distinction would be made on the basis of experience and they had no means of knowing who would be experienced until the nurse was interviewed, but there was evidence that the inclusion of experienced subjects depended on factors in addition to availability or chance. On ITU in Hospital B there was a tendency for the nurse in charge to select more senior nurses when data collection commenced, because they would be less threatened. Very newly appointed nurses were not approached at her request. This situation did not exist on wards, where nurses qualified for only a few days were chosen. On Ward 12 the sister promoted the inclusion of junior staff, while on Ward 13 the most senior staff nurse refused to participate.

Nurses with less experience were more likely to have 'A' levels:- $X^2 = 8.551$ 1*df* $p < 0.01$. They had been qualified for a shorter period of time:- $X^2 = 77.35$ 2*df* $p < 0.001$ and were more likely to lack postbasic qualifications:- $X^2 = 10.674$ 1*df* $p < 0.01$.

### Other Variables

As data collection progressed it became increasingly apparent that each ward had a unique atmosphere and an idea emerged that this might influence nurses' clinical performance, including infection control precautions, views on professional issues such as control of HAI and post-basic opportunities to extend knowledge, a view endorsed by other authors (see Chapter Three).

Consequently it was decided to abandon Question 4 on the interview schedule, which was not yielding very meaningful data, and replace it with three visual analogue scales (VAS) rated 0-100%, inviting subjects to rate their ward for learning opportunities, priority given to infection control and their own current job satisfaction. The system of classification into good and poor ward environment is shown on the Tables below. Although there were existing, more sophisticated instruments they were not used because of the demands on subjects' time completing the knowledge questionnaires. Data were collected only in Hospital B.

**Priority Given to Infection Control by the Nurses**

ITU nurses were more likely to consider that high priority was afforded to infection control (see Table 6.7):- $H = 9.87$ $2df$ $p < 0.007$, but all views tended to be positive.

**TABLE 6.7 Nurses' estimates of priority given to infection control within their clinical setting (Hospital B only)**

| | ITU | SURGICAL | MEDICAL | TOTALS | |
|---|---|---|---|---|---|
| | | | | N° | % |
| Poor (0-39%) | 0 | 2 | 1 | 3 | 3.49 |
| Fair (40-69%) | 3 | 14 | 9 | 26 | 30.2 |
| Good (70-100%) | 26 | 13 | 16 | 55 | 63.98 |
| Don't know | 1 | 1 | 0 | 2 | 2.33 |
| | 30 | 30 | 26 | 86 | |

### The ward as a learning environment

Perceptions did not vary with clinical setting (see Table 6.8):- H = 3.87 2*df* *p* <0.145 N.S. Most nurses held positive views.

**TABLE 6.8 Nurses' estimates of the ward as a learning environment (Hospital B only)**

| | ITU | SURGICAL | MEDICAL | TOTALS | |
|---|---|---|---|---|---|
| | | | | N° | % |
| Poor (0-39%) | 1 | 0 | 1 | 2 | 2.32 |
| Fair (40-69%) | 2 | 5 | 4 | 11 | 12.80 |
| Good (70-100%) | 27 | 24 | 20 | 71 | 82.56 |
| Don't know | 0 | 1 | 1 | 2 | 2.32 |
| | 30 | 30 | 26 | 86 | |

### Current Job Satisfaction

Table 6.9 shows subjects' estimates of current job satisfaction, indicating that for most it was good with no variation between units:- H = 2.45 2*df* *p* <0.294 N.S.

**TABLE 6.9 Nurses' estimates of current job satisfaction (Hospital B only)**

| | ITU | SURGICAL | MEDICAL | TOTALS | |
|---|---|---|---|---|---|
| | | | | N° | % |
| Poor (0-39%) | 1 | 1 | 2 | 4 | 4.65 |
| Fair (40-69%) | 3 | 10 | 7 | 20 | 23.26 |
| Good (70-100%) | 26 | 19 | 15 | 60 | 69.77 |
| Don't know | 0 | 0 | 2 | 2 | 2.32 |
| | 30 | 30 | 26 | 86 | |

**Relationship between priority to infection control, ward as a learning environment and job satisfaction**

Spearman's Rank Correlation Coefficient was used to correlate the scores of the above three variables:-

Priority to infection control and ward environment:-

$r_s = 0.426$ $p < 0.005$ $n = 84$

Priority to infection control and job satisfaction:-

$r_s = 0.422$ $p < 0.005$ $n = 84$

Ward environment and job satisfaction:-

$r_s = 0.486$ $p < 0.005$ $n = 84$

All results were significant, so the three scores were summated to yield a score for ward climate employed in further analysis. This was not significantly different between the three units (see Table 6.10):-
H = 2.71 $2df$ $p < 0.258$ N.S.

**TABLE 6.10 Ward Atmosphere Scores - Hospital B only**

| | MEAN | MEDIAN | RANGE | S.D |
|---|---|---|---|---|
| ITU | 68.39 | 70 | 40-83.3 | -- |
| Surgical | 62.24 | 63.33 | 40-86.6 | 1.43 |
| Medical | 63 | 63.33 | 20-90 | -- |
| All units | 64.70 | 66.60 | 20-90 | 1.43 |

**Evaluation and Summary: The Sample**

Most subjects were female and less than 36 years of age. There were marked differences between those employed in the two hospitals. Nurses in Hospital B tended to be educated to a higher standard, to be first level nurses, to have been qualified for a shorter period of time and to lack experience within their speciality.

However, ITU nurses were more likely to hold a relevant postbasic certificate irrespective of hospital. It was possible to recruit one hundred and seventy-three subjects and except for one incident (Ward 13) the research was well tolerated, a finding supported by others performing similar fieldwork (*Larson, McGinley and Grove, 1986; Larson et al, 1992*). However, genuine rate of participation is unknown, as some subjects discreetly absented themselves when the researcher arrived on the ward. Subjects were not selected by the researcher, but there was evidence of a degree of bias in the manner in which sisters promoted the participation of particular nurses. This may have influenced results from that area.

Selection of wards also lay beyond the control of the researcher and there was some indication that they had been suggested by managers on the basis of their existing reputation. For example, a senior nurse in Hospital A admitted that Ward 7 had been suggested because it was known to be problematic. Again, this could have been a source of bias, particularly in view of the striking difference in ward atmosphere which emerged. Ward atmosphere is a well-documented phenomenon (*Revans, 1964; Orton, 1981*) which merits further investigation in relation to the prevention of infection (see Recommendations for Future Research), particularly as there is evidence that good role models can influence practice (*Larson, 1983*) and educational campaigns at ward level have been most successful (*Lynch et al, 1991; Matthews, 1991*). It was unfortunate that it was possible to collect data systematically only in Hospital B, which appeared to provide a happier environment than Hospital A. A few individuals were clearly unhappy, but no particular ward in the second hospital emerged with an unfavourable climate.

This appeared to reflect genuinely high morale rather than lack of sensitivity within the method of assessment. A final source of bias relates to ward specialty. When designing the study it was intended to secure the participation of ten subjects on each of the general wards, but this was not possible because of low staffing levels on some of the designated medical wards. This did not have serious consequences for statistical analysis, but whether or not some of the "medical" wards could genuinely be considered as such is questionable, particularly Ward 12, where many investigations were so invasive that they were performed in theatre under general anaesthesia. It was not possible within the study design to analyse data from individual wards separately as, with no more than ten subjects each, statistical comparisons would be impossible, but by pooling data some of the wards' uniqueness was lost. For example, Ward 2 admitted patients for day surgery, Ward 3 catered for those undergoing major gut surgery, while Ward 4 specialised in limb and arterial surgery. Workload, procedures performed and infection risks to patients and staff clearly differed, as well as the way the work was organised, but data from all were analysed as the surgical unit in Hospital A. Each of the study aims will now be addressed in turn.

**Aim I To document facilities available to help nurses prevent HAI through routine procedures including hand decontamination, glove and sharps use.**

To fulfil Aim I, data were derived from fieldnotes and the Ward Facilities Checklist. General factors which may affect infection control practice are considered in this section, including ward layout and resources such as the infection control and occupational health services.

The following comparisons were made:-

i. Two hospitals, one employing an infection control nurse, the other not.

ii. Intensive care, surgical and medical units.

**Resources to control HAI in the two hospitals**

Resources available to control HAI were noted during early visits and discussions with senior nursing staff concerning ward architecture and organisation of the infection control services. During visits to arrange data collection on individual wards records were made of the alleged method of ward organisation and delivery of patient care. Brief fieldnotes were maintained as data collection progressed, augmented by the Ward Facilities Checklist.

**Architecture**

Hospital A

Hospital A was a large, modern hospital, serving an inner-city area in London. It employed the largest nursing force in Europe. All the wards and ITU had been built within the last twenty years. The wards were structurally similar, consisting of a central corridor with bays and two or three cubicles opening along one side and service rooms (bathroom, sluice, treatment room and nurses' station) facing them along the other. Three sinks were available in the corridor and in Wards 1, 3 and 5 also in the bays. Sinks were also present in cubicles, treatment room, sluice and nurses' station but, despite the recent design of the hospital, elbow taps were not always available (see TABLE 6.11).

The ITU was built on a "race track" design, with a central nurses' station and two bays on either side. Behind the nurses' station two cubicles, a sluice and treatment room housing blood gas monitoring equipment were situated.

Hospital B

Hospital B was a large teaching hospital serving a similar under-privileged inner-city London area. It consisted of three wings built at different times, housing wards of different architectural design. Wards in the South Wing, though recently upgraded, were still of the Nightingale type and, as they were different from any in from Hospital A, were excluded from the study. Wards in the North Wing, opened within the last 15 years, were of a "racetrack" design with beds in bays around a central "island" containing a nurses' station and service rooms. Wards in the West Wing, opened in the early 1960's, consisted of a long corridor with bays along one side faced by service rooms. The nursing station occupied a central position opposite the entrance. The cupboard holding drugs and the shelf where injections were prepared were some distance from the nearest sink in corridor wards. The ITU was in the West Wing. It was the oldest purpose-built unit in London, a modification of the basic ward design, but with a sluice and treatment room at each end replacing the day rooms. Blood gas monitoring equipment was kept in a technicians' room.

# Table 6.11a Results of Ward Facilities Checklist Hospital A

| | Nº Beds | Staffing | Sinks | Chlorhexidine | Handrub | Soap from Wall Dispenser | Bar Soap | Gloves | Sharps Boxes | Plastic Aprons | Disposal Bins | Infection Control Notices | Infection Control Policy | Ward Cleaning |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ward 1 ITU Unit ITU Hospital A | 12 | Over establishment | 4 in ward area (2 seldom used) treatment room, sluice* | All locations | Very sporadic at bedside | All locations | Appeared occasionally | Sterile in treatment room, non-sterile at bedside | Bedside, treatment room | Bedside | Pedal bins, all broken* or difficult to manipulate, bags at bedside | On display | On display | Frequent, but of fair standard only; syringes, blood stain etc on floor |
| Ward 2 Unit Surgical Hospital A | 28, six reserved for day cases | Satisfactory - reached establishment | At nurses' station*, sluice*, treatment, corridor and bays | Available only in treatment room and one cubicle | Available in bays | In treatment room, at bedside and sinks in corridor | Never seen | Sterile and non-sterile in treatment room | Nurses' station, treatment room, sluice and on drugs trolley | Sluice | Pedal bins broken* | On display | Never seen | Considered poor by researcher and staff |
| Ward 3 Surgical Hospital A | 28 | Satisfactory - reached establishment | Nurses' station*, treatment room, sluice*, bays, corridor | None available | Treatment room and corridor | Nurses' station and corridor | Never seen | Non-sterile gloves at nurses' station, treatment room, sluice | Nurses' station, sluice and bedside* of one patient | Nurses' station, treatment room, sluice, corridor | Pedal bins broken* | On display | Displayed at nurses' station | Thorough cleaning observed |
| Ward 4 Surgical Hospital A | 28 | Reached establishment but considered short of staff | Nurses' station*, treatment room, sluice*, bays corridor | Treatment room and sluice | Corridor | Nurses' station, treatment room, bays, corridors | Never seen | Sterile in treatment room. Non-sterile in sluice, treatment | Nurses' station*, treatment room*, some bedsides | Treatment room and sluice | Pedal bins | On display | Never seen | Observed, thorough |
| Ward 5 Medical Hospital A | 28 | Reached establishment | Nurses' station*, treatment room, sluice*, bays, corridors | Sluice | Nurses' station, corridor | Nurses' station, treatment room, corridor | Appeared at all sinks from time to time | Sterile and non-sterile in treatment room | Nurses' station, treatment, sluice, drug trolley, some bedsides | Nurses' station | Pedal bins two broken* | On display | Never seen | Observed, but not enthusiastic |
| Ward 6 Medical Hospital A | 30 | Under establishment | Nurses' station*, treatment room, sluice*, bedside, bays | Nurses' station, treatment room, sluice, bedside, bays* | Nurses' station, bedside and bays* | Nurses' station sluice, treatment room, bedside, bays | Bedside bays | Sterile gloves in treatment room. Ward had run out of non-sterile gloves | Nurses' station, treatment room, sluice, bedside, bays* | At varying locations throughout ward | Pedal bins one broken* in sluice | On display | On display | Not thorough |
| Ward 7 Medical Hospital B | 24 | Under establishment | Nurses' station*, treatment room, sluice*, bedside, bays | Cubicles | Cubicles | All locations | Never seen | Sterile in treatment room. Non-sterile in cubicles and treatment room | Treatment room, sluice, cubicles | Cubicles | Pedal bins | On display | On display | Not thorough |
| | | | *Not elbow taps | *Without lids or dispensers | *Without lids or dispensers | | | | *Sharps boxes observed over-full in some cases | | *Lid needed lifting by hands | | | |

Table 6.11b **Results of Ward Facilities Checklist** Hospital B

| | No Beds | Staffing | Sinks | Chlorhexidine | Handrub | Soap from Wall Dispenser | Bar Soap | Gloves | Sharps Boxes | Plastic Aprons | Disposal Bins | Infection Control Notices | Infection Control Policy | Ward Cleaning |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ward 8 ITU Unit/ITU Hospital B | 10 | Satisfactory - reached establishment | 3 in two areas (2 seldom used) treatment room, sluice' | All locations | At every bedside | None | Appeared occasionally | Sterile in treatment room, non sterile at bedside | Bedside, treatment room | Bedside | Pedal bins, all broken* or difficult to manipulate, bags at bedside | On display | On display | Frequent, but of fair standard only; syringes, blood stain etc on floor |
| Ward 9 Unit [illegible] Hospital B Racetrack design | 28 | Under-establishment 2 vacancies soon to be filled | Nurses' station clean and dirty, treatment rooms, sluice, bays | All locations except dirty treatment room | All locations except dirty treatment room | Treatment room | Never seen | Sterile and non sterile in treatment room | Nurses station, treatment room, sluice and on drugs trolley | Sluice | Pedal bins broken' | On display | Never seen | Considered poor by researcher and staff |
| Ward 10 Surgical Hospital B Racetrack design | 28 | Reached establishment for qualified staff, no learners through administrative error. Shortfall made good by agency staff | Nurses' station, treatment room, sluice, bays, corridor | All locations | Nurses' station, treatment room, sluice | Nurses' station and corridor | Never seen | Non sterile gloves at nurses' station treatment room, sluice | Nurses station, sluice and bedside* of one patient | Nurses station, treatment room, sluice, corridor | Pedal bins broken* | On display | Displayed at nurses' station | Thorough cleaning observed |
| Ward 11 Surgical Hospital B Corridor design | 28 | Satisfactory - reached establishment | Treatment room, sluice, bays, cubicles | All locations | Sluice only | Nurses' station, treatment room, bays, corridors | Never seen | Sterile in treatment room. Non sterile in sluice, treatment | Nurses' station*, treatment room*, some bedsides | Treatment room and sluice | Pedal bins | On display | Never seen | Observed, thorough |
| Ward 12 Medical Hospital B Corridor design | 28 | Reached establishment | Two in each corridor near bays, dirty and clean treatment rooms, sluice - often blocked | All locations | Treatment room | Nurses' station, treatment room, corridor | Appeared at all sinks from time to time | Sterile and non sterile in treatment room | Nurses' station, treatment, sluice, drug trolley, some bedsides | Nurses' station | Pedal bins two broken* | On display | Never seen | Observed but not enthusiastic |
| Ward 13 Medical Hospital B Corridor design | 28 | Under establishment | Two in each corridor near bays, dirty and clean treatment rooms, sluice | All locations | In corridor adjacent to bays, near medicine cupboard clean treatment room | Nurses' station, sluice, treatment room, bedside, bays | Bedside bays | Sterile gloves in treatment room. Ward had run out of non sterile gloves | Nurses' station treatment room, sluice, bedside bays* | At varying locations throughout ward | Pedal bins one broken* in sluice | On display | On display | Not thorough |
| Ward 14 Medical Hospital B Racetrack design | 28 | One vacancy soon to be filled | Nurses station, treatment room, sluice and bays | All locations' | All locations including outside cubicle used for barrier nursing | All locations | Never seen | Sterile in treatment room. Non sterile in cubicles and treatment room | Treatment room, sluice, cubicles | Cubicles | Pedal bins | On display | On display | Not thorough |
| | | | | 'Without lids or dispensers | 'Without lids or dispensers | | | | *Sharps boxes observed over-full in some cases | | 'Lid needed lifting by hands | | | |

**Infection Control Services**

## Hospital A

The infection control team serving Hospital A consisted of an infection control officer (consultant microbiologist) and an experienced infection control nurse holding a relevant qualification. A booklet held all the infection control policies and had been updated two years before the study commenced. Information was easily located, accurate, and, except for lack of advice concerning gloves, seemed comprehensive. The nursing budget was held by three senior Nurse Managers, one each for medicine, surgery and the acute units, but budgeting on individual wards was devolved to sisters responsible for ensuring adequate supplies of equipment, including gloves, sharps and hand decontaminants. In some cases a sister might hand responsibility for ordering supplies to a deputy, usually a staff nurse.

## Hospital B

Hospital B employed three consultant microbiologists, one holding the responsibility of infection control officer.

An infection control nurse had been employed in 1976, but left five years before the commencement of the study. There had never been any plans to replace the post, a decision made jointly between nursing management and the microbiologists. The infection control policy in this hospital consisted only of the precautions necessary when performing isolation for infected and immuno-compromised patients. The researcher was informed by the senior nurse manager that these policies lacked detail and needed thorough review, a judgement not refuted when they were eventually seen. No information on hand decontaminants, glove or sharps use was available.

In Hospital B information concerning the nursing budget was more difficult to obtain, but again budget-holding was devolved to ward sisters, who might delegate responsibility for ordering supplies to a deputy.

In both hospitals it was common to find disposable equipment marked with its price.

**Occupational Health Services**

Both hospitals had comprehensive occupational health services offering hepatitis B vaccine to nursing staff. In Hospital A a recent campaign of awareness had resulted in notices describing the action to take in the event of needlestick injury appearing on all wards.

**Results of the Ward Facilities Checklist**

<u>Hospital A</u>

From Tables 6.11a and 6.11b it is apparent that while structural features intended to help prevent HAI (ward layout, provision of sinks) were similar throughout Hospital A, staffing levels varied. Two wards (6 and 7) were understaffed, a problem that appeared to be of long standing. Although staffing levels were adequate on Ward 5, this ward had recently been severely under-staffed (see Table 6.12), while subjects on Ward 4 perceived themselves to be under pressure for this reason, although according to the hospital management this was not so. ITU was over-established. Availability and distribution of equipment throughout the wards was idiosyncratic. Handrub was in short supply in ITU where the infection control policy stipulated it should be used routinely.

According to the senior sister this was because wall-mounted holders would be difficult to fix, although handrub can stand in bottles at the bedside. There were other clear examples of incorrect application of the policy throughout the clinical areas included in the study: handrub replaced soap in dispensers on some medical and surgical wards and bar soap occasionally appeared (Wards 1 and 5) although explicitly forbidden. In some wards ordering, particularly gloves, was inconsistent and not always well planned. It became apparent that considerable "borrowing", especially gloves and aprons, occurred between wards, possibly to the detriment of those where planning was good. If the devolution of budgets to ward level had occurred to encourage cost-consciousness (as staff suggested during informal conversation with the researcher), some wards were able to achieve this by reducing supplies ordered, then "borrowing".

Provision of sharps boxes was satisfactory, but at some locations in Wards 3, 4 and 5 they were over-full on at least one occasion. Plastic aprons were always readily available.

Throughout the hospital nurses tended to wear aprons when washing and lifting patients and for other "dirty' tasks, but did not always change them between patients. Rings were worn by most nurses, and were not usually removed before performing aseptic technique. Many wore wrist watches during clinical work, sometimes impeding decontamination.

All wards were equipped with disposal bins at appropriate locations but on all but two (4 and 7) these were broken at one or several locations.

Staff could only dispose of equipment by touching the lid, leading to potential re-contamination of hands. Positive features revealed by the checklist included display of Infection Control Notices on every ward and prominent display of the Infection Control Policy on Wards 1, 3, 6 and 7.

<u>Hospital B</u>

Ward layout varied slightly in Hospital B, but both styles provided similar architectural features with potential to influence HAI, except that in corridor wards injections were prepared some distance from the nearest sink (Wards 11, 12 and 13).

All sinks were equipped with elbow taps and both chlorhexidine and handrub were available in every ward. Occasionally bar soap was seen on Wards 9 and 11, where pedal bins were broken. Aprons were seldom used throughout Hospital B, but it was unusual to see nurses wearing watches or rings other than wedding bands. Infection control notices were displayed on only two wards and the infection control policy, even when available, was never on view.

Staff recruitment and retention did not seem to be such a problem as in Hospital A (see Table 6.12). Wards 9, 10, 13 and 14 were short of staff, but apart from Ward 13, this was regarded as temporary.

**Portraits of the Wards**

Impressions of the wards and possible influences on standards of nursing care, including measures to reduce HAI acquired during fieldwork are presented on Tables 6.12a and 6.12b.

TABLE 6.12a Portrait of the Wards Hospital A

| WARD | SPECIALTY | ORGANISATION OF NURSING CARE | ATMOSPHERE | EVIDENCE OF TEACHING | IMPRESSION OF WORKLOAD | PATIENTS WITH INFECTIONS | COMMENTS |
|---|---|---|---|---|---|---|---|
| Ward 1 ITU | General intensive care | Individual patient care. Each nurse cared for one, occasionally two patients. A "runner" for the ward in general was always present | Pleasant. Morale high. Researcher always made welcome and genuine interest shown in the research | Teaching report. Clinical teaching for post registration students witnessed | Initially very busy, then very quiet | One patient with Pneumocystis carinii. Routine blood and body fluid precautions | Medical and paramedical staff interested in research and supportive |
| Ward 2 | General surgery | Team nursing. Day surgery patients | Pleasant. Morale high. Researcher welcome | Teaching for students observed | Staff claimed to be busy. Impression not shared by researcher | | Administratively a difficult ward - 6 consultants |
| Ward 3 | General & gut surgery | Team nursing | Pleasant. Some initial scepticism but researcher welcome | Teaching for all staff observed once | Busy, although consultant on holiday | | Reputation was of a very busy ward |
| Ward 4 | General & vascular surgery | Team nursing, but with trends towards task allocation | Pleasant, though hierarchical. Morale high. Researcher welcome | None observed | Traditional approach e.g. all patients in bed before doctor's round | | Ward was infamous for alleged traditional approach to care |
| Ward 5 | General medicine, rheumatology, neurology, three surgical beds | In transition to primary nursing | Variable atmosphere, depending on who was on duty. Researcher generally felt welcome or at least accepted | None observed, but teaching materials available | Heavy, slow pace rather than busy | | No surgical patients ever apparent despite three designated beds |
| Ward 6 | General medicine, renal medicine, dermatology | Dermatology patients segregated from renal patients. Two beds reserved for haemodialysis patients, care provided by specialist nurse | Unhappy. Morale low. Researcher accepted | None observed | Heavy and busy. 'Shortages of essential equipment, e.g. gloves, compounded nurses' difficulties | | Reputation as a poor learning environment. Staff showed some resentment of students |
| Ward 7 | Haematology | Team nursing | Unhappy. Researcher accepted | None observed | Heavy and busy. 'Shortages of equipment | Protective isolation. Staff had apparently developed their own protocols, which did not involve use of gloves | As for Ward 6 |

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**TABLE 6.12b Portrait of the Wards Hospital B**

| WARD | SPECIALTY | ORGANISATION OF NURSING CARE | ATMOSPHERE | EVIDENCE OF TEACHING | IMPRESSION OF WORKLOAD | PATIENTS WITH INFECTIONS | COMMENTS |
|---|---|---|---|---|---|---|---|
| Ward 8 ITU | General intensive care & post-operative cardiac surgery patients | Total patient care. Each nurse provided care for one or two patients. No "runner" | Pleasant. Morale high. Researcher always welcome | Lengthy teaching session every day | Brisk pace of work maintained throughout data collection period | Outbreak of Pseudomonas from theatre | Medical and paramedical staff interested and supportive of research |
| Ward 9 | General surgery | Team nursing | Pleasant. Morale high. Researcher always welcome | Keen interest in researcher shown by sister and teaching | Very high turnover | ----- | Very efficiently organised ward |
| Ward 10 | General surgery | Team nursing | Pleasant. Morale high. Researcher always welcome | Ward teaching witnessed | Rapid turnover | ----- | Organised and efficient ward |
| Ward 11 | Vascular & ear, nose and throat surgery | Nurses allocated to same patients throughout stay | Pleasant atmosphere Morale high. Researcher welcome | No teaching witnessed | Busy. Junior staff appeared under stress | ----- | |
| Ward 12 | Cardio-thoracic, with some medical & surgical patients | Never apparent | Reputation of a happy ward, but evidence of some staff and patient dissatisfaction | Learning materials available | Staff claimed to be busy, an impression not shared by researcher | Outbreak of Pseudomonas from theatre | Researcher not allowed on ward when it was busy. Staff sometimes defensive |
| Ward 13 | General medical | Primary nursing | Chaotic. Staff generally welcoming, but never organised. Researcher had to introduce herself and study at each visit. Evidence of marked staff dissatisfaction | None witnessed | Staff claimed to be busy. Researcher saw more evidence of disorganisation than genuinely heavy turnover | HIV, HBV, open pulmonary tuberculosis | Patients seemed happy and there was evidence of good care despite chaos |
| Ward 14 | General medicine, haematology | Staff allocated to a small group of patients throughout their stay. Immuno-suppressed patients nursed in isolation | Pleasant. Morale fair. Researcher accepted | Educational materials available | Busy ward | ----- | |

**Evaluation and Summary: The Ward Facilities Checklist**

The Checklist proved an effective method of collecting factual information about the wards, particularly when augmented by fieldnotes. On the whole, Hospital B was better equipped than Hospital A, although it lacked an infection control nurse and its policies needed updating.

The chief criticism of the checklist is its lack of rigor, precluding use in statistical analysis, but this could be overcome by employing a similar, more sophisticated measure published since the completion of data collection and currently undergoing validation (*Gledhill, Thomas, Streed et al, 1992*).

**Aim 2 To investigate nurses' perceptions of HAI: prevalence, threats to themselves and their patients, educational opportunities regarding HAI and use of effective strategies for prevention.**

Aim 2 was realised through analysis of the interview data, qr 5 and 11 on the knowledge questionnaires and the Likert Scale. Comparisons between the following were made.

i. Two hospitals, one employing an infection control nurse, the other not.
ii. Intensive care, medical and surgical units.
iii. Experienced nurses (three years or more within their specialty) and less experienced nurses (less than three years within their specialty). This section presents the results of the interview with each question appearing in the same order as on the interview schedule. Raw data are shown in Appendix 5.

**Results of the Interview**

***Question 1 What percentage of hospital patients develop infection?***

This was asked to establish perceptions of the threat of HAI. Responses were coded into two categories, realistic estimates (0-30%) and unrealistic estimates (over 30%). Table 6.13 shows that realistic estimates were made by less than half the sample. The remainder over-estimated risks. Thirty-six (20.81%) believed risks to be in excess of 50%, a vast over-estimate.

**TABLE 6.13 Number of nurses realistically estimating prevalence of HAI**

| | A | | B | | Both Hospitals | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| ITU | 12 | 40 | 9 | 30 | 21 | 35 |
| Surgical | 15 | 50 | 16 | 53.33 | 31 | 51.66 |
| Medical | 11 | 40.74 | 11 | 42.30 | 22 | 41.50 |
| | 38 | 43.67 | 36 | 41.86 | 74 | 42.77 |

There was no significant difference between hospital or clinical setting:-

$X^2 = 0.058$ 1*df* N.S $X^2 = 3.454$ 2*df* N.S

Opinions were not influenced by sociodemographic variables:-

Experience $X_2 = 3.391$ 2*df* N.S

Years Qualified $X^2 = 2.340$ 2*df* N.S

However, on Ward 7 all eight nurses over-estimated risks.

No significant differences emerged between nurses employed in the same clinical setting in different hospitals:-

ITU $X^2 = 0.659$ 1*df* N.S

Surgical $X^2 = 0.067$ 1*df* N.S

Medical $X^2 = 0.013$ 1*df* N.S

*Question 2 Do you think patients on your ward/unit are at particular risk of developing infection?*

Most nurses ($N$ = 129, 74.56%) believed their patients to be at particular risk (see Table 6.14)

**TABLE 6.14 Number of nurses estimating their patients to be at particular risk of HAI**

| | A | | B | | Both Hospitals | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| ITU | 26 | 86.66 | 28 | 93 33 | 54 | 90 |
| Surgical | 24 | 80 | 19 | 63.33 | 43 | 71.66 |
| Medical | 21 | 77.77 | 11 | 42 31 | 32 | 60.37 |
| | 71 | 81 61 | 58 | 67.44 | 129 | 74.56 |

Nurses in Hospital A were more likely to perceive patients to be at risk:- $X^2$ = 3.916 1*df* $p$ <0.05, as were those in ITU

$X^2$ = 13.383 2*df* $p$ =<0.001.

Nurses in medical wards within Hospital B were significantly less likely to consider their patients to be at particular risk of HAI:- $X^2$ = 6.966 1*df* $p$ <0.01.

Nurses who over-estimated risks of HAI believed patients to be at risk:- $X^2$ = 5.519 1*df* p <0.05, as did experienced nurses:- $X^2$ = 12.464 1*df* $p$ <0.001 and those who had been qualified longest:- $X^2$ = 10.974 2*df* $p$ <0.01.

**Reasons for considering patients to be at particular risk of infection**

Nurses who considered their patients to be at particular risk of HAI were invited to give reasons. Of those one hundred and twenty-nine (74.56%) who believed risks to be high within their clinical setting, the majority ($n$ = 101, 78.29%) considered this to be related to the type of patient, although a few in medical and surgical wards made a number of other suggestions with too few in each category to permit statistical analysis. Examples included poor facilities,lack of equipment and reliance on inexperienced or student nurses to give a high proportion of care.

During conversation nurses often mentioned specific risks to which their patients might be prone. The interview schedule had not been designed to capture a great deal of qualitative material in the form of additional comment, nor was there time to encourage all nurses to enlarge on this topic. However, twenty-eight, all in ITU, spontaneously referred to the tremendous risk posed by invasive devices.

*Question 3 All nurses are at risk of developing infections from patients. Do you think this risk is especially high on your ward/unit?*

Sixty-seven (38.72%) considered themselves particularly at risk (see Table 6.15).

**TABLE 6.15 Number of nurses perceiving themselves to be at particular risk of HAI**

| | A | | B | | Both Hospitals | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| ITU | 20 | 66.66 | 18 | 60 | 38 | 63 33 |
| Surgical | 7 | 23.33 | 6 | 20 | 11 | 36 66 |
| Medical | 12 | 44 45 | 4 | 15.39 | 16 | 30.18 |
| | 39 | 44 83 | 28 | 32.56 | 67 | 38.72 |

The following groups were significantly more likely to consider themselves at risk:-
Nurses who believed patients were at risk: $X^2 = 18.376$ 1*df* $p < 0.001$
Nurses in ITU: $X^2 = 23.507$ 2*df* $p < 0.001$
Nurses qualified the longest: $X^2 = 6.131$ 2*df* $p < 0.05$
Experienced nurses: $X^2 = 5.594$ 1*df* $p < 0.05$
There was no difference between hospitals: $X^2 = 3.264$ 1*df* N.S.

From Table 6.15 it is evident that more nurses on medical wards in Hospital A considered patients at risk, but no other differences emerged between surgical and ITU nurses in different hospitals: $X^2 = 0.287$ 1*df* N.S, $X^2 = 1.164$ 1*df* N.S. It was notable that on Ward 13 only one nurse considered herself at particular risk of infection, although this was the ward to which patients with HIV and classical communicable diseases (e.g. tuberculosis) were routinely admitted.

**Nurses ' reasons for considering themselves at risk of developing infection**

The sixty-seven (38.37%) nurses who considered themselves at particular risk were asked to give reasons. Of those sixty-five (37.50%) who responded, risks fell into two broad categories: those risks associated with factors in connection with the patient (*n* = 46, 70.77%) and those risks related to the nurse, such as being run down and thus prone to infection (*n* = 19, 29.23%).

Of those forty-six nurses who believed risks to be patient-related, most (*n* = 28, 60.86%) mentioned frequently handling blood and body fluids and the majority (*n* = 16, 57.13%) worked in ITU.

Only seven nurses in surgical wards and five in medical wards mentioned spontaneously that they could be at risk of infection through handling blood and body fluids. Other risks were expressed in general terms and usually alluded to respiratory infections believed to be disseminated by the airborne route:

> Subject 55: *"There are a lot of bugs flying about in a small, enclosed space ..... patients have nasty respiratory strains of infection, we get exposed collecting samples."*

**Nurses' reasons for not considering themselves to be at risk of developing infection**

Those nurses (*n* = 106, 61.28%) not considering themselves at particular risk were asked to give reasons. Sixty-four (60.38%) responses were obtained.

Throughout both hospitals a small number ($n$ = 4, 2.31%) felt they were not at risk because their patients' infections were not of a type to which a healthy individual would be susceptible. A further small percentage ($n$ = 9, 5.20%) could never recall a nurse developing infection from a patient and concluded threat to be minimal. Most however, ($n$ = 51, 29.48%) claimed that personal risks were contained because nursing standards were high, with good infection control precautions routinely taken. There was no significant difference between hospitals:
$X^2 = 3.264$ 1$df$ N.S.

**Risks attributed to blood and body fluids**

Although the aims of the interview included obtaining nurses' perceptions of risks specifically related to blood and body fluids, this question was not asked directly because it was hoped to obtain spontaneous comments, but as explained above, these were made by only twenty-eight nurses.

However, of the fifty-one nurses who claimed <u>not</u> to be at particular risk of infection because standards were high, it was apparent that twenty-five were referring specifically to blood and body fluid precautions. Thus, fifty-three (30.63%) of the total sample mentioned risk or lack of risk related to blood exposure without prompting. The remaining one hundred and twenty (69.37%) were then probed to determine whether blood was considered a particular risk. Twenty-four nurses (20%) of those probed considered blood a risk, compared to ninety-six (80%) who did not.

*Question 4 Do you consider awareness of the risk of infection to be high on your ward/unit?*

This question was superseded by the Visual Analogue Scales in Hospital B.

Most nurses in Hospital A perceived awareness to be good (see Table 6.16).

**TABLE 6.16 Responses to Question 4: Comparison of Units (Hospital A only)**

| | ITU | | SURGICAL | | MEDICAL | | TOTALS | |
|---|---|---|---|---|---|---|---|---|
| | N° | % | No | % | No | % | No | % |
| Good awareness | 21 | 70 | 22 | 73.34 | 17 | 62.97 | 60 | 68.96 |
| Not good | 3 | 10 | 4 | 13.33 | 3 | 11.11 | 10 | 11.49 |
| Other | 6 | 20 | 4 | 13.33 | 7 | 25.93 | 17 | 19.55 |
| | **30** | | **30** | | **27** | | **87** | |

*Question 5 I am going to show you a scale and on it I would like you to indicate how serious you think hepatitis B is. (Visual Analogue Scale shown)*

On the visual analogue scale the range of responses extended from 20-100%. Only twenty-one (12.13%) gave estimates below 60% suggesting that most nurses considered hepatitis B to represent a serious medical condition. This was borne out by the number of spontaneous comments:-

Subject 12 *"It can kill you, destroy your liver!"*

Nurses were categorised as "concerned" about hepatitis B if they estimated seriousness to fall between 20-79% and "very concerned" if estimates exceeded 80% (see Table 6.17).

**TABLE 6.17 Number of nurses "very concerned" about HBV**

| | A | | B | | Both Hospitals | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| ITU | 15 | 50 | 17 | 56.67 | 32 | 53.33 |
| Surgical | 11 | 39.67 | 11 | 39.67 | 22 | 36.66 |
| Medical | 14 | 51.86 | 12 | 46.16 | 26 | 49.05 |
| | 40 | 45.98 | 40 | 46.52 | 80 | 46.25 |

Nurses very concerned about HBV were not more likely to perceive themselves at particular risk of infection:- $X^2 = 0.190$ 1*df* N.S. There was no difference between clinical setting:- $X^2 = 3.596$ 2*df* N.S. or with experience:- $X^2 = 0.006$ 1*df* N.S. Nurses within the same clinical setting but different hospitals did not give different responses:-

ITU:- $X^2 = 0.606$ 1*df* N.S

Surgical:- $X^2 = 0.000$ 1*df* N.S

Medical:- $X^2 = 0.172$ 1*df* N.S

Wards 7 and 14 both admitted a high proportion of patients who had undergone multiple blood transfusions. Those with active hepatitis B would probably be admitted to Ward 13, yet not all nurses on these wards fell into the 'very concerned' category.

***Question 6. Have you been vaccinated against hepatitis B?***

The majority of nurses ($n$ = 126, 72.83%) had been vaccinated against HBV (see Table 6.18). This excluded one nurse in ITU Hospital A who had natural immunity following clinical infection thought to have developed after she had been exposed to blood from a carrier admitted to A and E haemorrhaging.

**TABLE 6.18 Number of nurses immunised against HBV**

| | A | | B | | Both Hospitals | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| ITU | 25 | 83.33 | 25 | 83.33 | 50 | 83.33 |
| Surgical | 19 | 63.33 | 21 | 70 | 40 | 66.66 |
| Medical | 19 | 70.37 | 17 | 65.39 | 36 | 67.92 |
| | 63 | 72.42 | 63 | 73.25 | 126 | 72.83 |

The following non-significant results were obtained:-

Perceived risks to self:- $X^2 = 2.863$ 1*df* N.S

Very concerned about HBV:- $X^2 = 0.0166$ 1*df* N.S

Clinical setting:- $X^2 = 5.744$ 1*df* N.S

Number of years qualified:- $X^2 = 2.472$ 2*df* N.S

Experience:- $X^2 = 3.294$ 1*df* N.S

Results did not vary between nurses in the same clinical setting but different hospitals:

Surgical:- $X^2 = 0.659$ 1*df* N.S

Medical:- $X^2 = 0.151$ 1*df* N.S

Although the nature of the client groups in Wards 6, 7, 13 and 14 suggested that these nurses could frequently be exposed to blood and blood products, some nurses had not been vaccinated on these wards.

*Question 7a:* ***Before qualifying did you receive any information about infection control?***

Most nurses ($n$ = 129, 74.56%) could remember pre-registration teaching about infection control other than the aseptic dressing technique (see Table 6.19).

**TABLE 6.19 Number of nurses recalling pre-registration information**

| | A | | B | | Both Hospitals | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| ITU | 16 | 53.33 | 23 | 76.66 | 39 | 65 |
| Surgical | 24 | 80 | 26 | 86.66 | 50 | 83.33 |
| Medical | 23 | 85.18 | 17 | 65.38 | 40 | 75.47 |
| | 63 | 72.42 | 66 | 76.75 | 129 | 74 56 |

Nurses in surgical units recalled pre-registration teaching more often:- $X^2$ = 7.293 2*df* $p$ <0.05, as did those immunised against HBV:- $X^2$ = 8.173 1*df* $p$ <0.01. All other tests yielded non-significant results:-

Prevalence of HAI:- $X^2$ = 0.001 1*df* N.S

Risks to patients:- $X^2$ = 2.494 1*df* N.S

"Very concerned" about HBV:- $X^2$ = 2.494 1*df* N.S

Experience:- $X^2$ = 1.510 1*df* N.S.

There was no difference between nurses in the same clinical setting but different hospitals where this was possible to test:-

ITU:- $X^2$ = 3.590 1*df* N.S

*Question 7b* ***Was this information adequate?***

Of those one hundred and twenty-nine (74.56%) nurses who could recall pre-registration teaching concerned with infection control, seventy-nine (61.24%) considered that at the time it had been adequate.

The nature of pre-registration teaching proved impossible to explore, because many nurses, especially those qualified for a number of years, could not remember which topics had been included.

*Question 8a Since qualifying have you received any information about infection control?*

Table 6.20 shows that one hundred and eight (62.43%) nurses recalled opportunities to extend knowledge of infection control post-registration, similar numbers in both hospitals.

**TABLE 6.20 Number of nurses recalling post-registration learning opportunities**

| | A | | B | | Both Hospitals | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| ITU | 25 | 83.33 | 23 | 76.66 | 48 | 80 |
| Surgical | 15 | 50 | 19 | 63.33 | 34 | 56.66 |
| Medical | 13 | 48.15 | 13 | 50 | 26 | 49.05 |
| | 53 | 60.92 | 55 | 63.96 | 108 | 62.43 |

In Hospital A ten nurses (11.49%) specifically mentioned input from an infection control nurse, and of these seven (8.05%) worked in ITU. In Hospital B six nurses (6.98%) mentioned input from the infection control nurse dating from previous employment. These were evenly distributed throughout the units. In Hospital A those who had contact with the infection control nurse all stated how helpful she was, while in Hospital B lack of an infection control nurse was often mentioned as a problem, especially when there was specific queries, such as disinfection of equipment.

The following groups were more likely to recall input:

| | |
|---|---|
| Nurses in ITU:- | $X^2 = 11.268$ $1df$ $p < 0.01$ |
| Those who estimated prevalence realistically:- | $X^2 = 4.106$ $1df$ $p < 0.05$ |
| Those who thought patients were at risk:- | $X^2 = 4.106$ $1df$ $p < 0.05$ |
| Those who had been qualified longest:- | $X^2 = 21.006$ $2df$ $p < 0.001$ |
| Experienced nurses:- | $X^2 = 6.737$ $1df$ $p < 0.01$ |

The following results were non-significant:

| | |
|---|---|
| Risk of infection to self:- | $X^2 = 2.508$ $1df$ N.S |
| Very concerned about HBV:- | $X^2 = 0.216$ $1df$ N.S |
| Immunisation against HBV:- | $X^2 = 1.662$ $1df$ N.S |

Nurses who recalled post-registration opportunities were not more likely to recall pre-registration teaching:- $X^2 = 2.501$ $1df$ N.S.

There were no differences between nurses within the same clinical setting but different hospitals:-

| | |
|---|---|
| ITU | $X^2 = 0.884$ $1df$ N.S. |
| Surgical:- | $X^2 = 0.077$ $1df$ N.S. |
| Medical:- | $X^2 = 0.021$ $1df$ N.S. |

There were no individual wards where every nurse claimed to have had or lacked post-basic opportunities to extend knowledge of infection control.

**Nature of post-basic opportunities to extend knowledge about infection control.**

Beyond simple classification into having or not having post-registration opportunities, subjects' responses to Question 8a were not easy to categorise, as some had difficulties remembering the nature of the input. It was also likely that subjects interpreted this question differently.

Nine (5.20%) nurses had pursued educational opportunities entirely through their own efforts, seeking journal articles and attending conferences at their own expense. While they regarded that they had opportunities, others actually receiving them within the workplace may not have recognised them, especially if they formed part of a course. Most of the sample, particularly those in ITU, must have attended study days concerned with intravenous additives, judging by the number of intravenous injections they performed. It seems reasonable to suppose that some infection control input was included, but this was seldom mentioned.

*Question 8b Was this adequate?*

One hundred and twenty-one (69.05%) nurses were not satisfied with post-basic opportunities to extend knowledge about infection control (see Table 6.21).

**TABLE 6.21 Number of nurses satisfied with post-basic opportunities**

| | A | | B | | Both Hospitals | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| ITU | 14 | 46.66 | 10 | 33.33 | 24 | 40 |
| Surgical | 12 | 40 | 8 | 26.66 | 20 | 33.33 |
| Medical | 5 | 18 5 | 3 | 11.54 | 8 | 15.09 |
| | 31 | 35.63 | 21 | 24.41 | 52 | 30.06 |

There was no significant difference between hospitals:-

$X^2 = 2.587$ 1*df* N.S.

Responses to this question were difficult to record because subjects were so voluble, even those who recalled input:-

Subject 11:- *"We need more input, especially barrier nursing. The doctors do one thing, we do another. We need more clear cut ideas of what to do.... More back up. It's half-hearted. We need regular sessions to avoid confusion."*

Subject 142:- *"We should have refreshers, updates that are ward-based. We need more lectures and to meet people in the path. lab so we know who to contact for help."*

Subject 147:- *"We need written protocols for lots of jobs on the wards e.g. both cleaning and updating on HIV."*

*Question 8c What else would be helpful?*

All subjects were asked this question, in view of comments which suggested that even when they had received input and considered it good, further information would always be welcome. A wide range of topics was mentioned, covering the broad field of infection control. One hundred and twenty nurses (69.36%) divided between the two hospitals wanted updating to continue at intervals regularly while they were in professional practice.

From Question 8 considered as a whole it could be concluded that nurses were very concerned with perceived gaps in their education concerning infection control and most gave a strong impression that they would have valued a longer interview with more time to discuss this. The researcher was frequently asked for advice concerning specific topics, especially on isolation techniques.

*Question 9a Availability of gloves*

One hundred and seventeen (67.63%) nurses stated that gloves were always available when needed. The remainder indicated that problems with supplies often or sometimes occurred (see Table 6.22).

**TABLE 6.22 Number of nurses perceiving problems with glove supplies**

| | A | | B | | Both Hospitals | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| ITU | 11 | 36.67 | 6 | 20 | 17 | 28.33 |
| Surgical | 10 | 33.64 | 2 | 6.67 | 12 | 20 |
| Medical | 21 | 77.77 | 6 | 23.08 | 27 | 50.94 |
| | 42 | 48.27 | 14 | 16.27 | 56 | 32.37 |

Nurses in Hospital A were significantly more likely to complain of poor supplies: $X^2 = 29.545$ 1*df* $p < 0.001$.

Nurses in medical units were more likely to perceive difficulties, chiefly in Hospital A:- $X^2 = 12.788$ 2*df* $p < 0.01$

Nurses in Hospital A gave the impression that although gloves could run out, this was avoided by the practice of borrowing from another ward. A typical comment is reproduced below:-

Subject N° 16 *" We'd borrow. Taking blood we have to have them. We'd take from other wards if we run out."*

Problems with gloves seemed most acute on Ward 6, where every nurse complained of shortages. On Ward 9 no nurse identified this as a problem. The following non-significant results were obtained with reference to reports on availability of gloves:-

| | |
|---|---|
| Experience:- | $X^2 = 0.499$ 1*df* N.S. |
| Risks to patients:- | $X^2 = 3.508$ 1*df* N.S. |
| Very concerned about HBV:- | $X^2 = 0.374$ 1*df* N.S. |

However, nurses who perceived difficulty obtaining gloves also perceived themselves to be at particular risk of infection:-

$X^2$ = 5.735 1*df* $p$ <0.05.

*Question 9b Availability of hand decontaminating agents*

**TABLE 6.23 Number of nurses perceiving problems with supplies of hand decontaminating agents**

| | A | | B | | Both Hospitals | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| ITU | 16 | 53 34 | 0 | 0 | 16 | 26 66 |
| Surgical | 10 | 33.4 | 2 | 6 67 | 12 | 20 |
| Medical | 13 | 48 15 | 1 | 3.84 | 14 | 26.41 |
| | 39 | 44 83 | 3 | 3 48 | 42 | 24 28 |

Problems were reported more often from Hospital A (see Table 6.23). Handrub was reported in short supply by all the sixteen nurses in ITU perceiving difficulties. Of those reporting problems there were no differences with regard to the following:-

| | |
|---|---|
| Experience:- | $X^2$ = 2.056 1*df* N.S |
| Risk to patients:- | $X^2$ = 0.045 1*df* N.S |
| Very concerned about HBV:- | $X^2$ = 0.206 1*df* N.S |

Nurses most concerned about hand decontaminant supplies were more likely to be concerned about risks to themselves:-

$X^2$ = 4.585 1*df* $p$ <0.05.

*Question 9c Availability of sharps boxes*

Twenty-two (12.72%) nurses perceived difficulty obtaining adequate supplies of sharps boxes (Table 6.24).

**TABLE 6.24 Number of nurses perceiving difficulty with supplies of sharps boxes**

| | A | | B | | Both Hospitals | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| ITU | 1 | 3.33 | 1 | 3.33 | 2 | 3.33 |
| Surgical | 4 | 13.34 | 6 | 20 | 10 | 16.66 |
| Medical | 5 | 18.51 | 5 | 19.23 | 10 | 18.86 |
| | 10 | 11.5 | 12 | 13.96 | 22 | 12.72 |

Little difference existed between hospitals but in the surgical and medical wards of both nurses reported more problems than in ITU, where sharps boxes were present at every bedside. The following non-significant results were obtained:-

Experience:- $X^2 = 2.189$ 1*df* N.S

Risks to patients:- $X^2 = 1.699$ 1*df* N.S

Very concerned about HBV:- $X^2 = 0.699$ 1*df* N.S

Glove supply problems:- $X^2 = 0.668$ 1*df* N.S

Nurses who considered themselves at risk of infection were more likely to perceive difficulties obtaining sharps boxes:- $X^2 = 4.715$ 1*df* $p < 0.05$.

*Question 9d Availability and position of sinks*

Table 6.25 indicates that forty-three (24.86%) nurses were not satisfied with the positioning and availability of sinks.

**TABLE 6.25 Number of nurses not satisfied with availability of sinks**

| | A | | B | | Both Hospitals | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| ITU | 12 | 40 | 12 | 40 | 24 | 40 |
| Surgical | 9 | 30 | 1 | 3.33 | 10 | 16.66 |
| Medical | 7 | 25.92 | 2 | 7.69 | 9 | 16.98 |
| | 28 | 32.19 | 15 | 17.44 | 43 | 24.86 |

Nurses in Hospital A and those on ITU were significantly less satisfied:-
$X^2 = 5.032$ $1df$ $p < 0.05$ $X^2 = 11.282$ $2df$ $p < 0.01$

ITU nurses frequently stated that ideally a sink should be provided at every bed-space. The following non-significant results were obtained:-

Experience:- $X^2 = 0.125$ $1df$ N.S

Perceived risks to patients:- $X^2 = 0.156$ $1df$ N.S

The data were inspected to determine whether nurses on corridor wards were more likely to report problems than those on "race track" wards, but no association emerged. None of the nurses on Ward 13 perceived problems although when performing injections they had to walk a considerable distance to the nearest sink.

*Question 9e Availability of aprons*

Table 6.26 shows that thirty-one (17.91%) nurses were not completely satisfied with supplies of aprons.

**TABLE 6.26 Number of nurses reporting shortages of aprons**

| | A | | B | | Both Hospitals | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| ITU | 3 | 10 | 3 | 10 | 6 | 16.66 |
| Surgical | 5 | 16.67 | 10 | 33.33 | 15 | 25 |
| Medical | 4 | 14.81 | 6 | 23.07 | 10 | 18.86 |
| | 12 | 13.8 | 19 | 22.10 | 31 | 17.91 |

There was no significant difference between hospitals or clinical setting:- $X^2 = 2.026$ $1df$ N.S

$X^2 = 4.636$ $2df$ N.S

The following non-significant results were obtained:-

Risks to patients:- $X^2 = 0.018$ $1df$ N.S

Experience:- $X^2 = 0.053$ $1df$ N.S

Nurses very concerned about HBV were more likely to report problems obtaining aprons, which help reduce exposure to blood and body fluids when there is risk of splashing:-

Very concerned about HBV:- $X^2 = 4.50$ $1df$ $p < 0.05$

*Question 10 How often do you think you wash/cleanse hands per shift?*

Nurses were categorised according to whether they under or overestimated their actual decontamination frequency (derived from the observation data) or whether their estimates were correct. Sixty-nine (39.88%) could not provide an answer. The other responses are shown on Table 6.27.

TABLE 6.27 Nurses' estimates of their own hand decontamination frequency

| | Hospital A | | | Hospital B | | | Both Hospitals | | |
|---|---|---|---|---|---|---|---|---|---|
| | Over | Under | Correct | Over | Under | Correct | Over | Under | Correct |
| ITU | 3 | 3 | 4 | 2 | 5 | 5 | 5 | 8 | 9 |
| Surgical | 5 | 7 | 11 | 6 | 6 | 17 | 11 | 13 | 28 |
| Medical | 5 | 7 | 5 | 4 | 5 | 4 | 9 | 12 | 9 |
| All | 13 | 17 | 20 | 12 | 16 | 26 | 25 | 33 | 46 |
| | 14.9% | 19.54% | 22.98% | 13.15% | 18.6% | 30.23% | 14.45% | 19.07% | 26.58% |

There was no association between hospital and estimated frequency:- $X^2 = 1.209$ $3df$ N.S.

However more nurses in surgical units were able to correctly estimate frequency:- $X^2 = 38.704$ $6df$ $p < 0.001$

The following relationships were examined but all were non-significant:-

| | | |
|---|---|---|
| q2 | Risks to patient:- | $X^2 = 0.360$ 3*df* N.S |
| q3 | Risks to self:- | $X^2 = 3.984$ 3*df* N.S |
| q8a | Post-basic opportunities:- | $X^2 = 2.164$ 3*df* N.S |
| q8b | Satisfaction with post-basic opportunities:- | $X^2 = 1.923$ 3*df* N.S |
| q9e | Provision of sinks:- | $X^2 = 1.094$ 3*df* N.S |
| q11 | Sore, dry hands:- | $X^2 = 2.277$ 3*df* N.S |

***Question 11 Do you suffer from skin problems on your hands at all?***

Table 6.28 shows that one hundred and twenty-two (70.52%) nurses complained of sore, dry hands.

**TABLE 6.28 Number of nurses complaining of sore, dry hands**

| | A | | B | | Both Hospitals | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| ITU | 20 | 66.66 | 27 | 90 | 47 | 78.33 |
| Surgical | 15 | 50 | 19 | 63.33 | 34 | 56.66 |
| Medical | 15 | 55.55 | 26 | 100 | 41 | 77.35 |
| | 50 | 57.47 | 72 | 83.73 | 122 | 70.52 |

Nurses in Hospital B were more likely to complain:-

$X^2 = 14.334$ 1*df* $p < 0.001$

Nurses in surgical wards were less likely to complain:-

$X^2 = 8.493$ 2*df* $p < 0.05$

There was no association with experience:-

$X^2 = 1.201$ 1*df* N.S

**Reasons for sore, dry hands**

Of those nurses who experienced sore, dry hands, the principle reason seemed to lie with the need to wash them so much, especially during long spells of duty, using harsh decontaminating agents or a combination of both (see Table 6.29).

**TABLE 6.29 Reasons for dry, sore hands**

| Reason | No Nurses | % Nurses |
|---|---|---|
| Washing hands a lot | 35 | 28.68 |
| Agent | 21 | 33.61 |
| Washing and Agent | 56 | 29.51 |
| Don't know | 10 | 8.20 |
| TOTAL | 122 | |

Chlorhexidine was universally recognised as the agent most damaging to hands. Comments were heartfelt and usually offered before the researcher had time to probe:-

Subject No 98:- *"Handwashing agents? We have hibiscrub - it's very cruel!"*

Subject No. 143:- *"Yes, dry and slightly red. It's to do with the hibiscrub. We need soap .....it would be more gentle!"*

Subject No.176:- *"Yes, red, sore and dry but not broken. It's better to wet hands before putting hibiscrub on."*

*Question 12* *Have you seen the infection control policy on this ward/unit?*

Table 6.30 indicates that ninety two (53.18%) nurses reported having seen the infection control policy in their current workplace.

**TABLE 6.30** **Number of nurses who could recall seeing the Infection Control Policy**

| | A | | B | | Both Hospitals | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| ITU | 18 | 60 | 14 | 46.66 | 32 | 53.33 |
| Surgical | 20 | 66.66 | 10 | 33.33 | 30 | 50 |
| Medical | 21 | 77.77 | 9 | 34.62 | 30 | 56.6 |
| | 59 | 67.82 | 33 | 38.38 | 92 | 53.18 |

Nurses in Hospital A were more likely to have seen the infection control policy:- $X^2 = 15.059$ 1*df* $p < 0.001$

There was no association with clinical setting:- $X^2 = 0.494$ 2*df* N.S. However, the results from nurses employed within the same clinical setting but different hospitals are interesting. Those in ITU were equally likely to have seen the policy: the difference between the hospitals occurred because those on surgical and medical wards in Hospital B had not seen their policy:-

ITU:- $X^2 = 1.071$ 1*df* N.S

Surgical:- $X^2 = 6.667$ 1*df* $p < 0.01$

Medical:- $X^2 = 11.345$ 1*df* $p < 0.001$

The following non-significant results were obtained:

~~Experience:- $X^2 = 2.049$ 1*df* N.S~~

Number of years since qualifying:- $X^2 = 0.647$ 2*df* N.S

Nurses on Ward 7 and 14 routinely performed isolation techniques for patients while those on Ward 13 provided care for patients with HIV and classic communicable diseases, but they had not necessarily seen the policy, although it is reasonable to suppose that they would need to refer to it.

*Qr 5 (Case Study I)* ***Action to be taken if skin presumed to be intact becomes splashed with blood of a known hepatitis B carrier.***

This question indicated opinion rather than knowledge as neither hospital provided definitive guidelines.

Eighteen (13.84%) would take the same action as if skin was broken (see Aim 3). A second group ($n$ = 55, 43.85%) would look for cuts and report the incident if these were present. All these nurses could be considered "cautious" about blood spillage compared to the fifty seven (42.31%) who stated they would wash the area but take no further action.

Nurses who were cautious about blood spillage were not more likely to be very concerned about HBV:- $X^2 = 1.090$ 1$df$ N.S., not more likely to be immunised against HBV:- $X^2 = 2.143$ 1$df$ N.S., not more likely to perceive difficulties concerned with glove supplies:- $X^2 = 1.264$ 1$df$ N.S., and not more likely to perceive themselves at risk of infection:- $X^2 = 0.999$ 1$df$ N.S.

***Qr 11. (Case Study 2)*** ***Degree of concern about becoming a carrier of MRSA (indication on visual analogue scale)***

This question was answered by one hundred and twenty-eight nurses (73.98%). Fifty-three (41.4%) rated concern over 70% on the VAS, forming a "very concerned" category. Most ($n$ = 118, 92.19%) provided reasons. For sixty-five (55.08%) the main fear was spreading MRSA to vulnerable patients. Thirteen (11.02%) mentioned enforced sick leave. Other comments made by a few nurses included spreading MRSA to relatives or fears for their own health. Some were couched in vague terms and meaning was not clear.

**The Relationship between Interview Data and Ward Atmosphere**

Where sufficient numbers existed the possible relationship between interview data and ward atmosphere for nurses in Hospital B was examined. To undertake analysis subjects were categorised into two groups:- those with low and medium estimates (0-69.99%) and those whose estimates were high (70-100%). The following non-significant results were obtained:-

| | | | | |
|---|---|---|---|---|
| Q1 | Prevalence of infection:- | $X^2 = 3.487$ | 1*df* | N.S |
| Q2 | Risk to patients:- | $X^2 = 0.170$ | 1*df* | N.S |
| Q3 | Risk to self:- | $X^2 = 0.059$ | 1*df* | N.S |
| Q5 | Concern about hepatitis B:- | $X^2 = 0.001$ | 1*df* | N.S |
| Q6 | Immunisation against hepatitis B:- | $X^{\cdot} = 0.382$ | 1*df* | N.S |
| Q8a | Postbasic opportunities to learn about HAI:- | $X^2 = 0.140$ | 1*df* | N.S |
| Q8b | Satisfaction with postbasic opportunities to learn about HAI:- | $X^2 = 0.002$ | 1*df* | N.S |
| ~~Q9a~~ | ~~Provision of gloves:-~~ | ~~$X^2 = 0.200$~~ | ~~1*df*~~ | ~~N.S~~ |
| Q9d | Provision of sinks:- | $X^2 = 1.762$ | 1*df* | N.S |
| Q10 | Estimating hand decontamination frequency:- | $X' = 1.560$ | 2*df* | N.S |
| Qr11 | Concern about MRSA:- | $X^2 = 3.424$ | 2*df* | N.S |

Nurses with higher scores for atmosphere were less likely to complain of apron shortages, a result which in isolation does not appear meaningful:- Q9e $X^2 = 4.650$ 1*df* $p < 0.05$.

**Summary and Evaluation: the interview**

The interview revealed differences in the views held by particular groups of nurses. Subjects in Hospital A were more likely to consider their patients to be at particular risk of infection and to complain about poor supply of hand decontaminants and gloves. These findings corroborate the results of the Ward Facilities Checklist which indicated under-provision in the first hospital. ITU nurses complained of poor provision of sinks significantly more often, irrespective of hospital. They also perceived themselves to be most at risk of infection, chiefly from blood and body fluids, although there were some odd, poorly expressed concerns regarding exposure to risk and means of transmission. Experienced nurses were more likely to over-estimate risks and to recall post-registration learning opportunities. There was additional evidence that particular individuals were "infection conscious" as they tended to over-estimate risks and to consider both themselves and patients to be at risk. Nurses in Hospital B were more likely to complain of sore, dry hands and unless employed in ITU, were unlikely to have glimpsed their infection control policy. No pattern emerged when interview questions were compared to data for ward atmosphere in Hospital B.

Originally the interview had been planned to promote participation in the study. By providing information about the research and answering queries it was hoped to dispel anxiety and encourage return of questionnaires.

Nurses were approached after observation for a discussion planned to take approximately 15 minutes, but often continuing much longer, providing an unexpected amount of qualitative information directly pertinent to the study aims, indicating that subjects were interested in the topic, had genuine concerns and held views they were able and willing to communicate to the researcher. There were no refusals to be interviewed. These findings support the literature, which demonstrates the interest and commitment to infection control shown by clinical nurses (*Ching and Seto, 1990; Gill and Slater, 1991*). Many of the topics suggested for inclusion in ward-based updates reported by *Matthews (1991)* were also mentioned here. Overall these results suggest that nurses' interest in HAI could be fostered. Their concerns are worthy of more detailed investigation (see Recommendations for Future Research) which has been undertaken so far only in relation to parenteral virus infections (*Searle, 1987; Bond et al, 1990; Kelsey, 1992*).

**Assessment of Opinions with the Likert Scale**

Maximum score was 100, with higher scores suggesting favourable opinions. Mean score for the whole sample was 80.95 (see Table 6.32). A normal distribution was obtained, but the range (63-100) indicated that all nurses showed favourable opinions.

**Results of the Likert Scale**

Nurses in the main study completed the Likert Scale unsupervised by the researchers. They were told that it was intended to elicit opinions, not knowledge. One hundred and thirt

(80.34%) responded (see Table 6.31).

TABLE 6.31 Response rate of the Likert Scale

| | A | | B | | Both Hospitals | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| ITU | 28 | 93.33 | 23 | 76.66 | 51 | 85 |
| Surgical | 29 | 96.66 | 24 | 80 | 53 | 88.33 |
| Medical | 26 | 86.66 | 9 | 34.61 | 35 | 66.03 |
| | 83 | 95.4 | 56 | 65.11 | 139 | 80.34 |

Nurses in Hospital A were significantly more likely to respond:-

$X^2 = 24.164$ 1*df* $p < 0.001$

Fewer responses were obtained from medical wards:

$X^2 = 11.928$ 2*df* $p < 0.01$

This was accounted for by the poor return from Wards 12, 13 and 14.

TABLE 6.32 Results of the Likert Scale

| | A Scores | B Scores | Both Hospitals Scores |
|---|---|---|---|
| ITU | 81.75 | 84.3 | 82.9 |
| Surgical | 76.83 | 81.44 | 78.96 |
| Medical | 80.58 | 83.42 | 81.29 |
| | 79.66 | 82.92 | 80.95 |

According to the Mann Whitney test opinions were significantly more favourable in Hospital B, but there was no association with clinical setting, assessed with the Kruskal Wallis test:-

W = 5127.5 $p < 0.0025$

H = 4.28 2*df* $p < 0.118$ N.S.

Nurses in surgical wards in Hospital B had significantly higher scores than their counterparts in Hospital A:- W = 711 $p < 0.0134$

No differences emerged between the other units:-

| | | | |
|---|---|---|---|
| ITU | W = 642.5 | $p$ <0.1076 | N.S. |
| Medical | W = 428 | $p$ <0.2820 | N.S. |

When individual wards were compared, scores were higher on ITU in Hospital B and lowest in Ward 3, which admitted patients undergoing gut surgery. Scores were also low on Ward 7, where considerable isolation nursing was undertaken. Experienced nurses' opinions were not significantly less favourable than those of their less experienced colleagues:- W= 4427 $p$ <0.1477

**The relationship between Likert data and socio-demographic data**

The following relationships were explored:-

| | |
|---|---|
| Number of years qualified | H = 5.27 2*df* $p$ <0.072 N.S |
| Priority given to infection control (Hospital B only):- | H = 0.28 2*df* $p$ <0.869 N.S |
| Job satisfaction (Hospital B only):- | H = 1.54 3*df* $p$ <0.674 N.S |
| Ward environment:- | H = 0.80 3*df* $p$ <0.849 N.S. |
| Age:- | W = 2801.5 $p$ <0.3950 N.S |
| Professional qualification:- | W = 8961 $p$ <0.0491 |
| Postbasic certificate:- | W = 4417 $p$ <0.0591 |

Overall, first level nurses and those holding a relevant postbasic certificate held significantly more favourable opinions towards infection prevention on the Likert Scale.

**Evaluation and Summary: the Likert Scale**

Although previous authors appear confident that negative rather than positive factors influence compliance with hand decontamination (*Larson and Killien, 1982; Bartzokas and Slade, 1991; Zimacoff et al, 1992*), the results of the Likert Scale modified for this study to include views pertaining to gloves and sharps, suggests that overall nurses held positive views. Scores fell within the range 63 to 100, which was the maximum.

This may reflect social desirability as it is possible that subjects would not wish to express negative views concerning a fundamental aspect of patient care which the researcher was obviously concerned about. An attempt was made to overcome response set by including some negatively-worded items, as recommended by *Carmines and Zeller (1979)*, but it would not be difficult for any subject to detect which response would place them in a favourable light. Use of the "undecided" category, regarded as problematic by some authorities (see *Oppenheim, 1966)* was conspicuously absent here.

Response rate was generally favourable ($n$ = 139, 80.34%) though significantly better throughout Hospital A and poor for medical wards. Despite this, many nurses seemed irked by the questions, as they often wrote copiously on the forms and many queries were raised by pre-pilot subjects during informal discussion, chiefly about the problematic statements later deleted through lack of correlation. Problems could have been anticipated, as at least one of the infection control experts commenting on content validity remained convinced that the Likert Scale was intended to assess knowledge.

The use of scales to measure complex constructs such as attitudes has attracted an enormous amount of criticism by social scientists (*Brewster-Smith, 1966*), including nurses (*Fielding, 1985; Corner, 1988*) who believe that ticking boxes, though convenient, is no substitute for the rich data obtained with open questions amenable to detailed content analysis, contributing to validity.

**The relationship between nurses' opinions of infection control assessed by the interview and Likert Scale**

The interview and Likert scale were intended to tap different aspects of nurses' views on infection. These data sets were examined in relation to one another using the chi square test. Nurses were categorised as those with favourable views towards infection prevention (Likert score 63-80) and those with very favourable views (Likert score 81-100). The following non-significant results were obtained:-

| | | | | |
|---|---|---|---|---|
| Q1 | Prevalence of infection:- | $X^2 = 0.148$ | 1*df* | N.S |
| Q2 | Risk to patients:- | $X^2 = 2.535$ | 1*df* | N.S |
| Q3 | Risk to self:- | $X^2 = 2.534$ | 1*df* | N.S |
| Q5 | Concern about HBV:- | $X^2 = 0.618$ | 1*df* | N.S |
| Q8b | Satisfaction with postbasic opportunities:- | $X^2 = 0.032$ | 1*df* | N.S |
| Q9a | Provision of gloves:- | $X^2 = 0.313$ | 1*df* | N.S |
| Q9b | Hand decontamination:- | $X^2 = 0.116$ | 1*df* | N.S |
| Q9d | Provision of sinks:- | $X^2 = 0.024$ | 1*df* | N.S. |
| Q9e | Aprons:- | $X^2 = 0.971$ | 1*df* | N.S |
| Q11a | Sore hands:- | $X^2 = 0.293$ | 1*df* | N.S |
| Q12 | Policy:- | $X^2 = 0.552$ | 1*df* | N.S |
| Qr11 | Concern about MRSA:- | $X^2 = 1.284$ | 1*df* | N.S. |

**Evaluation and Summary: Assessing Opinions of Infection Control**

Problems encountered with the Likert Scale involved content validity and social desirability rather than statistical testing of validity and reliability. As subjects were so co-operative during interviews it is possible to conclude that potentially this method appears to have more to offer than fixed response scales.

**AIM 3 To investigate nurses' knowledge of infection control and HAI**

Comparisons were made between the following groups:-

i. Two hospitals, one employing an infection control nurse, the other not.
ii. Intensive care, surgical and medical units.
iii. Experienced and less experienced nurses.

**Variables affecting response to the knowledge questionnaires**

Response rate was 75.14% for the entire sample (see Chapter Five). It was not associated with sociodemographic variables:-

Experience:- $X^2 = 0.032$ 1*df* N.S
Postbasic qualifications:- $X^2 = 0.032$ 1*df* N.S
'A' levels $X^2 = 2.655$ 1*df* N.S

Response rate was examined in relation to the interview data on the basis that nurses more concerned about HAI might respond. This was borne out in the results:- responders were significantly more likely to consider their patients at risk, to have seen the infection control policy in their current workplace and to complain of sore, dry hands which accompany frequent handwashing (see Chapter Five).

| | | |
|---|---|---|
| Q1 | Prevalence of HAI:- | $X^2 = 0.326$ 1*df* N.S |
| Q2 | Risk to patients:- | $X^2 = 6.602$ 1*df* $p < 0.05$ |
| Q3 | Risk to nurses:- | $X^2 = 8.100$ 1*df* $p < 0.01$ |
| Q5 | Concern about HBV:- | $X^2 = 0.097$ 1*df* N.S |
| Q6 | Vaccination against HBV | $X^2 = 0.661$ 1*df* N.S |
| Q8a | Postbasic opportunities to learn about HAI:- | $X^2 = 0.021$ 1*df* N.S |
| Q8b | Satisfaction with postbasic opportunities:- | $X^2 = 3.570$ 1*df* N.S |
| Q11 | Sore, dry hands:- | $X^2 = 6.640$ 1*df* $p < 0.01$ |
| Q12 | Policy | $X^2 = 4.279$ 1*df* $p < 0.05$ |

Nurses who scored highly on the Likert scale (81-100) did not necessarily return questionnaires:- $X^2 = 2.281$ 1*df* N.S

The result of each questionnaire is presented below, followed by the effects of sociodemographic variables. Finally, individual questions are analysed. Raw data for Aim 3 are presented in Appendix 5.

## RESULTS OF THE QUESTIONNAIRES

### Case Study 1 Blood and Body Fluid Precautions

Case Study 1 was scored out of 28. Mean score for the one hundred and thirty nurses was 18.70 (66.78%). Knowledge was significantly greater in Hospital B:- W = 4463.5 $p < 0.0002$. However, there was no significant difference between clinical settings (see Table 6.33):- H = 1.97 2*df* $p < 0.374$ N.S.

**TABLE 6.33 Results of Case Study I. Blood/Body Fluid Precautions (mean scores)**

| | A | | B | | Both Hospitals | |
|---|---|---|---|---|---|---|
| | mean | % | mean | % | mean | % |
| ITU | 17.96 | 64 41 | 21 26 | 75.92 | 19.45 | 69 46 |
| Surgical | 17.67 | 63.1 | 19.10 | 68.21 | 18.25 | 65 17 |
| Medical | 17 16 | 61 28 | 21 25 | 75.89 | 18.18 | 64.92 |

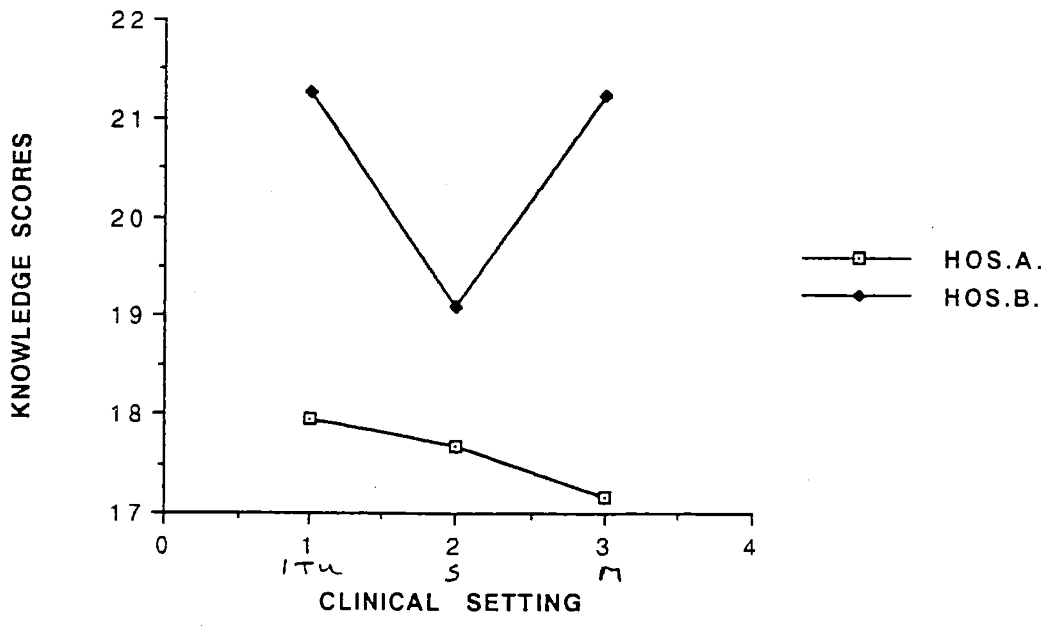
The results of ANOVA confirm the above findings: hospital, not clinical setting was significantly associated with higher scores:-

| | | |
|---|---|---|
| Hospital | $F(1, 130) = 13.63$ | $p < 0.000$ |
| Unit | $F(2, 130) = 0.86$ | $p < 0.424$ N.S |
| Hospital/Unit | $F(2, 130) = 1.03$ | $p < 0.359$ N.S |

From the raw data it was apparent that mean score was highest on Ward 12 (24, 85.71%) where three graduates were employed and lowest on Ward 5 (16.71, 59.76%).

Figure 6.1 shows that nurses in the same clinical specialty scored differently according to hospital. Knowledge was higher in both intensive care units, but whereas nurses in medical wards in Hospital B knew almost as much as those in ITU, medical nurses knew least in Hospital A.

**FIGURE 6.1 Results of Case Study 1**



**Case Study 2 Contact Precautions**

Case Study 2 in its final form was scored out of 44. Mean score for the one hundred and thirty nurses was 24.27 (55.15%) with a significant difference between the hospitals:- W = 4903 $p$ <0.0162 N.S The result was similar on all three units (see Table 6.34).

H = 0.53 2$df$ $p$ <0.768 N.S

**TABLE 6.34 Results of Case Study 2 Contact Precautions**

| | A | | B | | Both Hospitals | |
|---|---|---|---|---|---|---|
| | mean | % | mean | % | mean | % |
| ITU | 25.57 | 58.11 | 23.91 | 54.43 | 24.63 | 55.97 |
| Surgical | 24.07 | 54.70 | 25.58 | 58.13 | 24.55 | 55.79 |
| Medical | 21.08 | 47.9 | 30 | 68.18 | 23.31 | 52.97 |

This was confirmed by ANOVA.

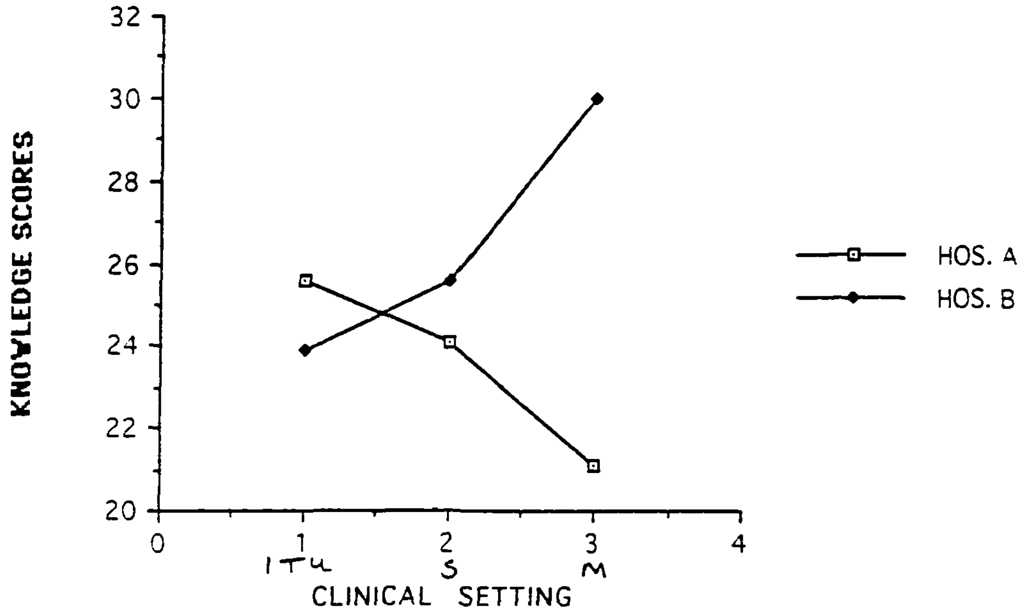
Knowledge was greater in Hospital B, especially on medical units:-

| | | |
|---|---|---|
| Hospital | F (1, 130) = 3.78 | $p$ <0.054 |
| Unit | F (2, 130) = 0.09 | $p$ <0.912 N.S. |
| Hospital/Unit | F (2, 130) = 3.75 | $p$ <0.026 |

Scores were highest on Ward 14 (33.20, 75.45%) and lowest on Ward 11 (18, 40.9%), although these results must be interpreted with caution, as response rate from Ward 14 was low.

Again, scores for nurses in the same specialty but different hospitals do not follow the same pattern (see Figure 6.2).

**Figure 6.2 Results of Case Study 2**




## Principles of Microbiology Questionnaire

This questionnaire was scored out of 72. Mean score for the one hundred and twenty-nine nurses completing it was 33.92 (47.11%). Scores were significantly higher in Hospital B:- W = 4684 $p$ <0.0123. However, no difference was observed with clinical setting (see Table 6.35). H = 2.55 $2df$ $p$ <0.280 N.S

**TABLE 6.35 Results of the Principles of Microbiology Questionnaire**

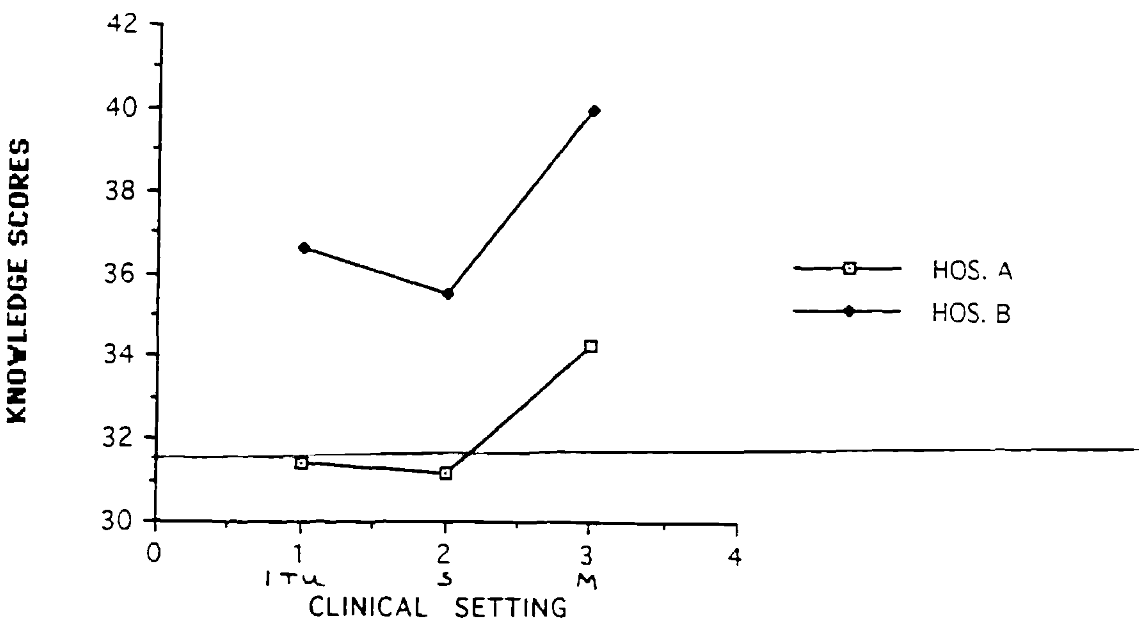
| | A | | B | | Both Hospitals | |
|---|---|---|---|---|---|---|
| | mean | % | mean | % | mean | % |
| ITU | 31.43 | 43.65 | 36 59 | 50.81 | 33 70 | 46.8 |
| Surgical | 31.18 | 43.3 | 35.53 | 49.34 | 32.94 | 45.75 |
| Medical | 34 29 | 47 62 | 40 | 55 55 | 35 72 | 49 61 |

The above result was confirmed by ANOVA: hospital was associated with a difference in scores, but not clinical setting:-

| | | | |
|---|---|---|---|
| Hospital | $F\ (1, 129) = 10.30$ | $p < 0.000$ | |
| Unit | $F\ (2, 129) = 1.81$ | $p < 0.168$ | N.S. |
| Hospital/Unit | $F\ (2, 129) = 0.03$ | $p < 0.973$ | N.S. |

In this case, knowledge scores for nurses in the same clinical setting but different hospitals follow the same pattern (see Figure 6.3).

**Figure 6.3 Results of Principles of Microbiology**



## Knowledge of Hand Hygiene for Specific Nursing Procedures

The Knowledge of Hand Hygiene for Specific Nursing Procedures was scored out of 52. Mean score for the one hundred and twenty-eight nurses completing it was 31.95 (61.14%). Scores were similar regardless of hospital or unit (see Table 6.36).

W = 5242 $p$ <0.4724 N.S

H = 3.52 2$df$ $p$ <0.172 N.S

**TABLE 6.36 Results of the Knowledge of Hand Hygiene Associated with Specific Nursing Procedures**

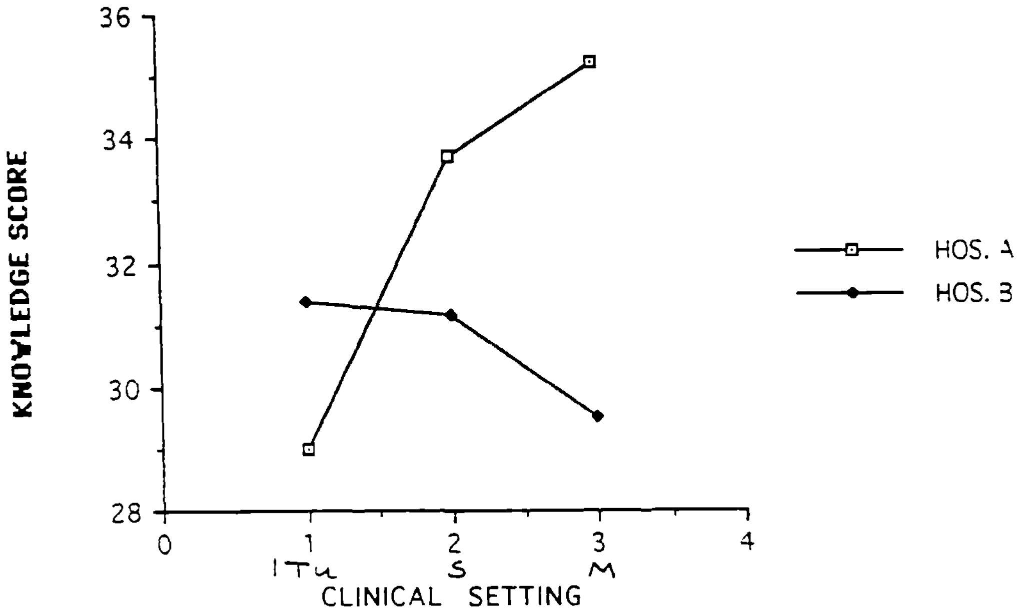
| | A | | B | | Both Hospitals | |
|---|---|---|---|---|---|---|
| | mean | % | mean | % | mean | % |
| ITU | 29 | 55.76 | 31.36 | 60.30 | 30.04 | 57.76 |
| Surgical | 33.7 | 64.8 | 31.16 | 59.92 | 32.65 | 62.78 |
| Medical | 35.42 | 68.11 | 29.5 | 56.73 | 33.94 | 65.26 |

ANOVA confirmed the above results:-

| | | | |
|---|---|---|---|
| Hospital | F (1, 128) = 0.35 | $p$ <0.555 | N.S |
| Unit | F (2, 128) = 1.27 | $p$ <0.284 | N.S |
| Hospital/Unit | F (2, 128) = 1.33 | $p$ <0.268 | N.S. |

The highest score was obtained from Ward 5 (38.57, 74.17%) and the lowest from Ward 11 (22, 42.30%). Figure 6.4 reveals that nurses' scores in the same clinical setting but different hospitals did not follow the same pattern.

**Figure 6.4 Results of Knowledge of Hand Hygiene**




One of the study aims was to examine the effect of nurses' experience on knowledge. This had no effect:

Case Study 1 $F(2, 130) = 0.226$ $p < 0.226$ N.S

Case Study 2 $F(2, 130) = 0.02$ $p < 0.900$ N.S

Principles of Microbiology $F(2, 129) = 0.02$ $p < 0.900$ N.S

Knowledge of Hand Hygiene for Specific Nursing Procedures

$F(2, 128) = 1.06$ $p < 0.306$ N.S

Other sociodemographic variables are examined below.

**Case Study 1 Blood and Body Fluids Precautions**

No significant results were obtained:-

| | |
|---|---|
| Postbasic certificate: | $F(2, 130) = 0.19$ $p < 0.664$ N.S |
| 'A' levels: | $F(2, 130) = 2.03$ $p < 0.156$ N.S |
| Professional nursing qualification: | $F(2, 130) = 0.50$ $p < 0.479$ N.S |
| Number of years qualified: | $F(2, 130) = 0.01$ $p < 0.907$ N.S |

**Case Study 2 Contact Precautions**

Only one significant result was obtained: knowledge was greater for registered general nurses. However, this must be interpreted with caution, as numbers of second level nurses were small, and the only second level nurse employed in Hospital B failed to return questionnaires:-

| | |
|---|---|
| Professional nursing qualification: | $F(2, 130 = 4.87$ $p < 0.029$ |
| Postbasic certificate: | $F(2, 130) = 0.000$ $p < 0.988$ N.S |
| 'A' levels: | $F(2, 130) = 0.88$ $p < 0.351$ N.S |
| Number of years qualified: | $F(2, 130) = 0.14$ $p < 0.711$ N.S |

**Principles of Microbiology**

All results were non-significant:-

| | |
|---|---|
| Postbasic certificate: | $F(2, 129) = 0.02$ $p < 0.900$ N.S |
| 'A' levels: | $F(2, 129) = 1.07$ $p < 0.303$ N.S |
| Professional nursing qualification: | $F(2, 129) = 1.30$ $p < 0.257$ N.S |
| Number of years qualified: | $F(2, 130) = 0.14$ $p < 0.711$ N.S |

**Knowledge of Hand Hygiene for Specific Nursing Procedures**

All results were non-significant:-

Postbasic certificate: $F (2, 128) = 0.38$ $p < 0.537$ N.S

'A' levels: $F (2, 125) = 1.25$ $p < 0.266$ N.S

Professional nursing qualification: $F (2, 129 = 0.79$ $p < 0.376$ N.S

Number of years qualified: $F (2, 129) = 1.93$ $p < 0.167$ N.S

**Relationship between Ward Atmosphere and Knowledge**

Spearman's Rank Correlation Coefficient was used to examine the relationship between ward atmosphere (measured on visual analogue scales) and questionnaire results in Hospital B.

There was one significant finding: high scores for ward atmosphere were associated with high scores on the Knowledge of Hand Hygiene for Specific Nursing Procedures:-

Case Study 1 $r_s = -0.139$ N.S $n = 50$

Case Study 2 $r_s = -0.139$ N.S $n = 50$

Principles of Microbiology $r_s = -0.163$ N.S $n = 50$

Knowledge of Hand Hygiene for Specific Nursing Procedures

$r_s = 0.220$ $p < 0.05$ $n = 50$

The Mann Whitney test was performed to determine whether nurses scoring highly on one questionnaire would do well on the others. All results were significant:-

Case Study 1 and Principles of Microbiology

$W = 9713$ $p < 0.000$

Case Study 2 and Principles of Microbiology

$W = 12069$ $p < 0.000$

Case Study 1 and Knowledge of Hand Hygiene for Specific Nursing Procedures

$W = 11005.5$ $p < 0.000$

Case Study 2 and Knowledge of Hand Hygiene for Specific Nursing Procedures

$W = 12729.5 \quad p < 0.000$

Principles of Microbiology and Knowledge of Hand Hygiene for Specific Nursing Procedures

$W < 17113.5 \quad p < 0.05$

Case Study 1 and Case Study 2

$W = 20969 \quad p < 0.000$

**Relationship between knowledge and opinions of HAI and infection control**

Each of the knowledge questionnaires was analysed in conjunction with questions from the interview schedule and total score of the Likert scale.

Knowledge and Interview Data

The interview yielded mainly nominal and ordinal data, so the chi square test was employed to examine these relationships. It was necessary to categorise data from the knowledge scores to make this possible, as recommended by *Bryman and Cramer (1990).*

**Case Study 1. Blood and Body Fluid Precautions**

Poor knowledge was categorised as score 0-15. Adequate and good levels were categorised as 16-28.

There was one significant finding: higher scores appeared to be associated with complaints of sore dry hands (Q11)

$X^2 = 3.908 \;\; 1df \;\; p < 0.05$

This may have occurred by chance in the light of the large number of tests performed.

All other findings were non-significant:-

| | | |
|---|---|---|
| Q1 | Prevalence of infection:- | $X^2 = 0.007$ 1*df* N.S |
| Q2 | Risk to patients:- | $X^2 = 0.500$ 1*df* N.S |
| Q3 | Risks to self:- | $X^2 = 1.611$ 1*df* N.S |
| Q5 | Concern about HBV | $X^2 = 0.012$ 1*df* N.S |
| Q6 | Vaccination against HBV | $X^2 = 3.00$ 1*df* N.S |
| Q8a | Postbasic opportunities to learn about infection control:- | $X^2 = 1.644$ 1*df* N.S |
| Q8b | Satisfaction with postbasic opportunities to learn about infection control:- | $X^2 = 1.475$ 1*df* N.S |
| Q9a | Concern about glove supplies:- | $X^2 = 2.324$ 1*df* N.S |
| Q9b | Concern about supplies of hand decontaminating agents:- | $X^2 = 3.157$ 1*df* N.S |
| Q9c | Concern about supplies of sharps boxes:- | $X^2 = 0.761$ 1*df* N.S |
| Q9d | Provision of sinks:- | $X^2 = 1.778$ 1*df* N.S |
| Q9e | Concern about supplies of aprons:- | $X^2 = 0.093$ 1*df* N.S |
| Q10 | Estimated handwashing frequency:- | $X^2 = 5.754$ 1*df* N.S |
| Q12 | Hospital policy:- | $X^2 = 0.455$ 1*df* N.S |

## Case Study 2. Contact Precautions

Nurses were categorised into two groups: poor scores (0-20) and adequate scores (21-44). No findings were significant:-

| | | |
|---|---|---|
| Q1 | Prevalence of infection:- | $X^2 = 1.794$ 1*df* N.S |
| Q2 | Risk to patients:- | $X^2 = 0.035$ 1*df* N.S |
| Q3 | Risks to self:- | $X^2 = 1.115$ 1*df* N.S |
| Q8a | Postbasic opportunities to learn about infection control:- | $X^2 = 2.620$ 1*df* N.S |
| Q8b | Satisfaction with postbasic opportunities to learn about infection control:- | $X^2 = 0.687$ 1*df* N.S |
| Q9a | Concern about supplies of gloves:- | $X^2 = 0.877$ 1*df* N.S |
| Q9b | Concern about supplies of hand decontaminating agents:- | $X^2 = 1.152$ 1*df* N S |

| | | |
|---|---|---|
| Q9d | Provision of sinks:- | $X^2 = 0.032$ 1*df* N.S |
| Q9e | Concern about supplies of aprons:- | $X^2 = 0.403$ 1*df* N.S |
| Q10 | Estimated handwashing frequency:- | $X^2 = 1.170$ 1*df* N.S |
| Q11 | Sore, dry hands:- | $X^2 = 0.325$ 1*df* N.S |
| Q12 | Hospital policy:- | $X^2 = 0.202$ 1*df* N.S |

### Principles of Microbiology

Nurses were categorised into two groups:- very poor scores (0-15) and better scores (16-72). No significant findings emerged:

| | | |
|---|---|---|
| Q1 | Prevalence of HAI:- | $X^2 = 1.205$ 1*df* N.S |
| Q2 | Risk to patients:- | $X^2 = 0.017$ 1*df* N.S |
| Q3 | Risks to self:- | $X^2 = 3.211$ 1*df* N.S |
| Q5 | Concern about HBV:- | $X^2 = 0.235$ 1*df* N.S |
| Q6 | Vaccination against HBV:- | $X^2 = 0.032$ 1*df* N.S |
| Q8a | Postbasic opportunities to learn about infection control:- | $X^2 = 0.622$ 1*df* N.S |
| Q8b | Satisfaction with postbasic opportunities to learn about infection control:- | $X^2 = 1.014$ 1*df* N.S |
| Q9a | Concern about glove supplies:- | $X^2 = 0.326$ 1*df* N.S |
| Q9b | Concern about supplies of hand decontaminating agents:- | $X^2 = 0.006$ 1*df* N.S |
| Q9c | Concern about supplies of sharps boxes:- | $X^2 = 2.895$ 1*df* N.S |
| Q9d | Provision of sinks:- | $X^2 = 1.023$ 1*df* N.S |
| Q9e | Concern about supplies of aprons:- | $X^2 = 0.036$ 1*df* N.S |
| Q10 | Estimated handwashing frequency:- | $X^2 = 1.853$ 3*df* N.S |
| Q11 | Sore, dry hands:- | $X^2 = 0.666$ 1*df* N.S |
| Q12 | Hospital policy:- | $X^2 = 0.513$ 1*df* N.S |

### Knowledge of Hand Hygiene for Specific Nursing Procedures

Nurses were categorised into two groups:- poor scores (0-26) and adequate scores (27-52). There was one significant finding.

Scores were higher for nurses who were satisfied with postbasic learning opportunities for HAI (Q8b)

$X^2 = 5.581$ 1*df* $p < 0.05$

Again, this may have occurred by chance in view of the many tests performed.

No other significant results were obtained:-

| | | |
|---|---|---|
| Q1 | Prevalence of infection:- | $X^2 = 1.436$ 1*df* N.S |
| Q2 | Risk to patients:- | $X^2 = 0.005$ 1*df* N.S |
| Q3 | Risks to self:- | $X^2 = 1.536$ 1*df* N.S |
| Q5 | Concern about HBV:- | $X^2 = 1.007$ 1*df* N.S |
| Q6 | Vaccination against HBV:- | $X^2 = 1.142$ 1*df* N.S |
| Q8a | Postbasic opportunities to learn about infection control:- | $X^2 = 3.407$ 1*df* N.S |
| Q9a | Concern about glove supplies:- | $X^2 = 0.645$ 1*df* N.S |
| Q9b | Concern about supplies of hand decontaminating agents:- | $X^2 = 1.439$ 1*df* N.S |
| Q9d | Provision of sinks:- | $X^2 = 0.084$ 1*df* N.S |
| Q9e | Concern about supplies of aprons:- | $X^2 = 0.099$ 1*df* N.S |
| Q10 | Estimated handwashing frequency:- | $X^2 = 1.066$ 1*df* N.S |
| Q11 | Sore, dry hands:- | $X^2 = 0.797$ 1*df* N.S |
| Q12 | Hospital policy:- | $X^2 = 0.527$ 1*df* N.S |

**Knowledge and Likert Data**

Spearman's Rank Correlation Coefficient indicated that all the knowledge scores except for the Knowledge of Hand Hygiene for Specific Nursing Procedures were positively associated with high Likert ratings (score 81-100):-

| | |
|---|---|
| Case Study 1 | $r_s = 0.189$ $p < 0.05$ $n = 130$ |
| Case Study 2 | $r_s = 0.165$ $p < 0.05$ $n = 130$ |

Principles of Microbiology $r_s = 0.168$ $p < 0.05$ $n = 129$
Knowledge of Hand Hygiene for Specific Nursing Procedures
rs = 0.041 N.S. $n = 128$

**Effect of Hospital, Clinical Setting and Likert Ratings on Knowledge**

All Knowledge scores (except Hand Hygiene) were associated with hospital effects additional to positive correlation with Likert scores, so ANOVA was employed to examine their combined effects.

**Case Study 1**

Likert ratings no longer appear significant for Case Study 1, but the hospital effect remains considerable:-

| | | |
|---|---|---|
| Hospital | F (1, 130) = 8.46 | $p < 0.005$ |
| Unit | F (2, 130) = 0.18 | $p < 0.837$ N.S. |
| Likert | F (2, 130) = 0.89 | $p < 0.628$ N.S. |

**Case Study 2**

This calculation was impossible to perform because there were too few nurses in some categories.

**Principles of Microbiology**

Both hospital and Likert ratings were associated with knowledge scores. The Likert effect is most significant:-

| | | |
|---|---|---|
| Hospital | F (2, 129) = 4.63 | 0.034 |
| Unit | F (2, 129) = 0.66 | $p < 0.517$ N.S. |
| Likert | F (2, 129) = 1.89 | $p < 0.011$ |

Attention will now be turned to the results of individual questions.

## Results of Individual Questions on the Knowledge Questionnaires

Some responses were judged as adequate (correct) even though a maximal score of 4 could not be awarded, either because it was not complete or entirely accurate (see Chapter Five). The results of individual questions below follow this scheme. They are presented for the sample as a whole.

### Case Study 1. Blood and Body Fluid Precautions

Table 6.37 below shows the number of nurses responding adequately to questions concerned with blood and body fluid precautions.

**TABLE 6.37 Case Study 1. Results of Individual Questions**

| | | SATISFACTORY | | NOT SATISFACTORY | |
|---|---|---|---|---|---|
| | | N | % | N | % |
| Q1 | Precautions for handling blood /body fluids | 95 | 73.07 | 35 | 26.93 |
| Qr2a | Concept of carriage for HBV | 114 | 87.69 | 16 | 12.31 |
| Qr2b | Requirement for Universal Precautions | 78 | 60 | 52 | 40 |
| Qr3 | HIV precautions | 125 | 96.15 | 5 | 3.85 |
| Q4 | Safe action following needlestick injury | 97 | 74.61 | 33 | 25.39 |
| Q6 | Risks of catherisation | 69 | 53.07 | 63 | 46.93 |
| Q7 | Antibiotic resistance | 113 | 86.92 | 17 | 13.08 |

### Case Study 2 Contact Precautions

Responses to individual questions are presented on Table 6.38 below:-

**TABLE 6.38 Case Study 1. Results of Individual Questions**

| | | SATISFACTORY | | NOT SATISFACTORY | |
|---|---|---|---|---|---|
| | | N | % | N | % |
| Qr8 | Threats posed by MRSA | 112 | 86.15 | 18 | 13.85 |
| Qr9 | Route of transmission | 71 | 54.15 | 59 | 45.85 |
| Qr10a | Value of gloves to control MRSA | 105 | 80.76 | 25 | 19.24 |
| Qr10b | Value of handwashing to control MRSA | 121 | 93.07 | 9 | 6.93 |
| Qr10d | Single room, door open to control MRSA | 31 | 23.84 | 99 | 76.16 |
| Qr10g | Mask to control spread of MRSA | 36 | 27.69 | 94 | 72.31 |
| Qr10i | Apron to control spread of MRSA | 88 | 67.69 | 42 | 32.31 |
| Qr10j | Overshoes to control spread of MRSA | 72 | 55.38 | 58 | 44.62 |
| Qr10k | Value of haircovering to control spread of MRSA | 86 | 66.15 | 44 | 33.85 |
| Qr10l | Value of disposable crockery and cutlery to control spread of MRSA | 38 | 29.23 | 92 | 70.77 |

## Principles of Microbiology

Table 6.39 below presents the results of individual questions.

**TABLE 6.39 Principles of Microbiology: results of individual questions**

| | | SATISFACTORY | | NOT SATISFACTORY | |
|---|---|---|---|---|---|
| | | N | % | N | % |
| Qr12 | Ability to name nosocomial pathogens | 41 | 31.53 | 88 | 68 47 |
| Qr13a | Transmission of micro-organisms | 84 | 65.11 | 45 | 30.89 |
| Qr13b | Chief mode of transmission | 83 | 64.34 | 46 | 35.66 |
| Qr14 | Portals of entry | 55 | 42.63 | 74 | 57.37 |
| Qr15 | Patients at risk | 78 | 60.46 | 51 | 39.54 |
| Qr16 | Ranking HAI in order of frequent occurrence | 21 | 16.27 | 108 | 83.73 |
| Qr17 | Infection and carriage | 60 | 46.51 | 69 | 53.49 |
| Qr18 | Gram staining reaction | 50 | 38.75 | 79 | 61.25 |
| Qr19a | Body fluids and HIV transmission | 78 | 60.46 | 51 | 39.54 |
| Qr19b | Body fluids and HBV transmission | 26 | 20.31 | 103 | 79.69 |

## Knowledge of Hand Hygiene for Specific Nursing Procedures

The results of individual parts of the Knowledge of Hand Hygiene for Specific Nursing Procedures could not be analysed in the above manner, because a single, overall score was given.

20.4% achieved less than half marks.

**Internal Analysis of the Questionnaires**

Analysis proceeded to explore possible associations between individual questions on the four questionnaires. As some responses contained raw scores between 0 and 4, this data could be considered ordinal, but would inevitably have contained many ties, while numbers in some categories would have been small.

To overcome these problems each response was analysed according to whether it was satisfactory or unsatisfactory and the chi square statistic was used with the resulting nominal data.

*Qr1* *Precautions which should be taken when handling blood and body fluids*

Three significant results emerged:-

Nurses who scored adequately were more likely to have adequate understanding of the concept of HBV carriage (Qr2a):-

$X^2 = 7.892$ $2df$ $p < 0.05$

They recognised the need for universal precautions regardless of the patient's known antibody status (Qr2b):-

$X^2 = 5.956$ $1df$ $p < 0.05$.

They also knew how to safeguard themselves if they sustained a needlestick injury (Qr4):-

$X^2 = 6.259$ $1df$ $p < 0.05$

Their knowledge of the carriage of micro-organisms was not generally good, however (Qr17), and they did not necessarily know which body fluids would be likely to transmit HBV or HIV (Qr19a, 19b).

| | | | |
|---|---|---|---|
| Qr17 | $X^2 = 0.016$ | $1df$ | N.S. |
| Qr19a | $X^2 = 2.323$ | $1df$ | N.S. |
| Qr19b | $X^2 = 1.709$ | $1df$ | N.S. |

*Qr2a Concept of Carriage for HBV*

No significant results were obtained when Qr2a was compared to other relevant topics:-

| | | | |
|---|---|---|---|
| Qr2b | $X^2 = 1.130$ | 1*df* | N.S. |
| Qr2b | $X^2 = 4.429$ | 2*df* | N.S. |

*Qr2b Requirement for Universal Precautions regardless of the patient's known antibody status*

No significant results were obtained:-

| | | | |
|---|---|---|---|
| Qr4 | $X^2 = 2.444$ | 1*df* | N.S. |
| Qr19b | $X^2 = 1.189$ | 1*df* | N.S. |

*Qr6 Recognising risks of urinary tract infection for a patient with a long term indwelling Foley catheter (more than three days)*

All results were non-significant:-

| | | | |
|---|---|---|---|
| Qr 7 | $X^2 = 0.004$ | 1*df* | N.S. |
| Qr13a | $X^2 = 2.667$ | 1*df* | N.S. |
| Q13b | $X^2 = 0.071$ | 1*df* | N.S. |
| Qr14 | $X^2 = 0.129$ | 1*df* | N.S. |
| | $X^2 = 0.002$ | 1*df* | N.S. |
| Qr16 | $X^2 = 0.197$ | 1*df* | N.S. |

*Qr7 Concept of bacterial antibiotic measures resistance*

No significant results were obtained:-

| | | | |
|---|---|---|---|
| Qr8 | $X^2 = 3.746$ | 2*df* | N.S. |

*Qr8 Understanding threats of MRSA*

Two significant findings emerged: nurses with adequate scores were more likely to understand how MRSA is spread (Qr9) and the concept of bacterial carriage (Qr17):-

$X^2 = 6.563$ 2*df* $p < 0.05$

$X^2 = 6.129$ 1*df* $p < 0.05$

They were not necessarily able to answer questions about reducing spread correctly:-

| | | | |
|---|---|---|---|
| Qr13a | $X^2 = 2.527$ | 2*df* | N.S. |
| Qr13b | $X^2 = 1.717$ | 2*df* | N.S. |

*Qr9 Route of transmission of MRSA*

One significant result emerged: nurses who knew that MRSA is spread by direct contact had adequate understanding of the concept of bacterial carriage (Qr17)

$X^2 = 6.129$ 1*df* $p < 0.05$

No other significant results were obtained:-

| | | | |
|---|---|---|---|
| Qr13a | $X^2 = 2.821$ | 1*df* | N.S. |
| Qr13b | $X^2 = 0.007$ | 1*df* | N.S. |

*Qr10a Value of gloves to prevent the spread of MRSA*

Two significant results were obtained. Nurses who knew that gloves would be very important knew how MRSA is transmitted (Qr9)

$X^2 = 4.327$ 1*df* $p < 0.05$

They also recognised the importance of handwashing (Qr10b):-

$X^2 = 17.069$ 1*df* $p < 0.001$

Other results were not significant:-

| | | | |
|---|---|---|---|
| Qr8 | $X^2 = 0.089$ | 2*df* | N.S. |
| Qr13b | $X^2 = 0.017$ | 1*df* | N.S. |
| Qr17 | $X^2 = 0.794$ | 2*df* | |

*Qr13 Transmission of micro-organisms*

Both findings were significant: nurses who knew how bacteria are disseminated also knew how bacteria gain access to internal tissues

Qr14 $X^2 = 3{,}858$ 1*df* $p < 0.05$

They also understood the concept of bacterial carriage

Qr17 $X^2 = 5.576$ 1*df* $p < 0.05$

*Qr19a Recognising which body fluids transmit HIV*

Nurses who scored highly in Qr19a also scored highly concerning a similar question on HIV (Qr19b):-

$X^2 = 5.391$ 1*df* $p < 0.05$

Knowledge of Hand Hygiene for Specific Nursing Procedures

One significant result was obtained: nurses who scored highly on knowledge concerning the handling of blood and body fluids (Qr1) scored better:-

$X^2 = 6.290$ 1*df* $p < 0.05$

No other results were significant

| | | | |
|---|---|---|---|
| Qr2a | $X^2 = 0.185$ | 1*df* | N.S. |
| Qr2b | $X^2 = 0.315$ | 1*df* | N.S. |
| Qr6 | $X^2 = 0.090$ | 1*df* | N.S. |
| Qr7 | $X^2 = 1.457$ | 1*df* | N.S. |
| Qr9 | $X^2 = 0.755$ | 1*df* | N.S. |
| Qr10a | $X^2 = 0.229$ | 1*df* | N.S. |
| Q13a | $X^2 = 0.001$ | 1*df* | N.S. |
| Qr13b | $X^2 = 0.080$ | 1*df* | N.S. |
| Qr17 | $X^2 = 0.765$ | 1*df* | N.S. |

**Relationship between individual questions and interview data**

Each response, coded as satisfactory or unsatisfactory, was examined in relation to data from the interview.

*Qr2a Concept of carriage for HBV*

All results were non-significant:-

| | | | | |
|---|---|---|---|---|
| Q3 | (Risk to self) | $X^2 = 4.036$ | 2*df* | N.S. |
| Q8a | (Postbasic opportunities) | $X^2 = 1.665$ | 2*df* | N.S. |
| Q8b | (Satisfaction with postbasic opportunities) | $X^2 = 0.369$ | 2*df* | N.S. |

*Qr2b Universal Precautions for all patients irrespective of known antibody status*

There was one significant finding: nurses who answered correctly were more likely to be fully immunised against HBV (Q6):-

$X^2 = 4.073$ 1*df* $p < 0.05$

All other results were non-significant:-

| | | | | |
|---|---|---|---|---|
| Q3 | (Risks to self) | $X^2 = 0.628$ | 1*df* | N.S. |
| Q5 | (Concern about HBV) | $X^2 = 0.516$ | 1*df* | N.S. |
| Q8a | (Postbasic opportunities) | $X^2 = 1.769$ | 1*df* | N.S. |
| Qr8b | (Satisfaction with postbasic opportunities) | $X^2 = 0.566$ | 1*df* | N.S. |
| Q12 | (Policy) | $X^2 = 0.525$ | 2*df* | N.S. |
| Qr5 | (Caution with blood exposure) | $X^2 = 0.019$ | 2*df* | N.S. |
| Qr11 | (Concern about MRSA) | $X^2 = 0.707$ | 1*df* | N.S. |

*Qr4 Appropriate action following needlestick injury*

There was one significant finding: nurses with adequate knowledge were more likely to be very concerned about HBV (Q5)

$X^2 = 7.488$ 1*df* $p < 0.05$

No other results were significant:-

| | | | | |
|---|---|---|---|---|
| Q3 | (Risks to self) | $X^2 = 0.086$ | 1*df* | N.S. |

## Case Study 1 Blood and Body Fluid Precautions

***Qr1 Precautions when handling blood and body fluids***

All results were non-significant:-

| | | | | |
|---|---|---|---|---|
| Q3 | (Risks to self) | $X^2 = 0.137$ | 1*df* | N.S. |
| Q5 | (Concern about HBV) | $X^2 = 0.043$ | 1*df* | N.S. |
| Q6 | (Vaccination against HBV) | $X^2 = 0.112$ | 1*df* | N.S. |
| Q9a | (Glove supply) | $X^2 = 1.878$ | 1*df* | N.S. |
| Q9c | (Supply of sharps boxes) | $X^2 = 0.138$ | 1*df* | N.S. |
| Q9b | (Supply of hand decontaminating agents) | $X^2 = 2.619$ | 1*df* | N.S. |
| Q9d | (Supply of aprons) | $X^2 = 0.086$ | 1*df* | N.S. |
| Q9e | (Availability of sinks) | $X^2 = 3.383$ | 1*df* | N.S |
| Q6 | (Vaccination against HBV) | $X^2 = 0.257$ | 1*df* | N.S. |
| Q8a | (Postbasic opportunities) | $X^2 = 1.028$ | 1*df* | N.S. |
| Q8b | (Satisfaction with postbasic opportunities) | $X^2 = 1.192$ | 1*df* | N.S. |
| Q12 | (Policy) | $X^2 = 0.640$ | 1*df* | N.S. |
| Qr5 | (Caution about blood exposure) | $X^2 = 2.215$ | 2*df* | N.S. |

***Qr6 Recognising risks of urinary tract infection for a patient with a long term indwelling Foley catheter (more than three days)***

No significant results were obtained:-

| | | | | |
|---|---|---|---|---|
| Q2 | (Risk to patient) | $X^2 = 0.278$ | 1*df* | N.S. |
| Q8a | (Postbasic opportunities) | $X^2 = 0.129$ | 1*df* | N.S. |
| Q8b | (Satisfaction with postbasic opportunities) | $X^2 = 2.311$ | 1*df* | N.S. |
| Q9a | (Glove supply) | $X^2 = 0.447$ | 1*df* | N.S. |
| Q9b | (Supply of hand decontaminating agents) | $X^2 = 2.009$ | 1*df* | N.S. |
| Q9e | (Provision of sinks) | $X^2 = 0.385$ | 1*df* | N.S. |
| Q12 | (Policy) | $X^2 = 2.224$ | 1*df* | N.S. |

*Qr7* *Concept of antibiotic resistance*

No significant results were obtained:-

| | | | | |
|---|---|---|---|---|
| Q1 | (Prevalence of HAI) | $X^2 = 2.954$ | 1*df* | N.S. |
| Q2 | (Risk to patient) | $X^2 = 0.556$ | 1*df* | N.S. |
| Q8a | (Postbasic opportunities) | $X^2 = 0.721$ | 1*df* | N.S. |
| Q8b | (Satisfaction with postbasic opportunities) | $X^2 = 0.002$ | 1*df* | N.S. |

**Case Study 2 Contact Precautions**

*Qr8* *Understanding threats of MRSA*

One significant result was obtained: nurses with sore, dry hands through handwashing were more likely to score highly (Q11)

$X^2 = 7.460$ 1*df* $p < 0.01$

All other results were non-significant:-

| | | | | |
|---|---|---|---|---|
| Qr1 | (Prevalence of HAI) | $X^2 = 1.490$ | 2*df* | N.S. |
| Q8a | (Postbasic opportunities) | $X^2 = 1.005$ | 2*df* | N.S. |
| Q8b | (Satisfaction with postbasic opportunities) | $X^2 = 0.789$ | 2*df* | N.S. |
| Q9a | (Glove supply) | $X^2 = 1.902$ | 2*df* | N.S. |
| Q12 | (Policy) | $X^2 = 1.870$ | 1*df* | N.S. |

*Qr9* *Route of transmission for MRSA*

No results were significant:-

| | | | | |
|---|---|---|---|---|
| Qr1 | (Prevalence of HAI) | $X^2 = 3.282$ | 1*df* | N.S. |
| Q2a | (Risk to patients) | $X^2 = 0.628$ | 1*df* | N.S. |
| Q8a | (Postbasic opportunities) | $X^2 = 0.662$ | 1*df* | N.S. |
| Q8b | (Satisfaction with postbasic opportunities) | $X^2 = 1.754$ | 1*df* | N.S. |
| Q9a | (Glove supply) | $X^2 = 1.115$ | 1*df* | N.S. |
| Q9b | (Supply of hand decontaminating agents) | $X^2 = 0.085$ | 1*df* | N.S. |
| Q9d | (Supply of aprons) | $X^2 = 1.531$ | 1*df* | N.S. |
| Q9e | Sinks | $X^2 = 1.996$ | 1*df* | N.S. |
| Q12 | (Policy) | $X^2 = 1.995$ | 1*df* | N.S. |
| Qr11 | (Concern at becoming MRSA carrier) | $X^2 = 0.537$ | 1*df* | N.S. |

*Qr10a* ***Wearing gloves to attend a patient with MRSA***

No significant results were obtained:-

| | | | | |
|---|---|---|---|---|
| Qr1 | (Prevalence of HAI) | $X^2 = 0.292$ | 1*df* | N.S. |
| Q2a | (Risk to patients) | $X^2 = 1.238$ | 1*df* | N.S. |
| Q3 | (Risk to self) | $X^2 = 2.965$ | 1*df* | N.S. |
| Q8a | (Postbasic opportunities) | $X^2 = 0.427$ | 1*df* | N.S. |
| Q8b | (Satisfaction with postbasic opportunities) | $X^2 = 0.397$ | 1*df* | N.S. |
| Q9a | (Provision of gloves) | $X^2 = 0.008$ | 1*df* | N.S. |
| Q12 | (Policy) | $X^2 = 2.596$ | 1*df* | N.S. |

*Qr10b* ***Washing hands to attend a patient with MRSA***

Numbers in some categories were too small for statistical tests to be performed.

*Qr10d* ***Nursing a patient with MRSA in a single room***

Nurses with high scores were less concerned about developing infection themselves (Q3)

$X^2 = 5.33$ 1*df* $p < 0.05$

They were more likely not to recall postbasic education (Q8a) and to be dissatisfied with this (Q8b)

$X^2 = 4.48$ 1*df* $p < 0.05$

$X^2 = 3.859$ 1*df* $p < 0.05$

Other results were not significant:-

| | | | | |
|---|---|---|---|---|
| Qr1 | (Prevalence of HAI) | $X^2 = 0.968$ | 1*df* | N.S. |
| Q2a | (Risk to patients) | $X^2 = 2.687$ | 1*df* | N.S. |
| Q12 | (Policy) | $X^2 = 1.302$ | 1*df* | N.S. |

***Qr10g*** ***Wearing a mask to attend patients with MRSA***

No results were significant:-

| | | | | |
|---|---|---|---|---|
| Q2a | (Risk to patients) | $X^2 = 0.595$ | 1*df* | N.S. |
| Q3 | (Risk to self) | $X^2 = 0.000$ | 1*df* | N.S. |
| Q8a | (Postbasic opportunities) | $X^2 = 2.141$ | 1*df* | N.S. |
| Q8b | (Satisfaction with postbasic opportunities) | $X^2 = 0.219$ | 1*df* | N.S. |
| Q12 | (Policy) | $X^2 = 1.302$ | 1*df* | N.S. |

***Qr10h*** ***Wearing a cotton gown to attend a patient with MRSA***

No singnificant results were obtained:-

| | | | | |
|---|---|---|---|---|
| Q2a | (Risk to patients) | $X^2 = 2.228$ | 1*df* | N.S. |
| Q3 | (Risk to self) | $X^2 = 0.014$ | 1*df* | N.S. |
| Q8a | (Postbasic opportunities) | $X^2 = 0.245$ | 1*df* | N.S. |
| Q8b | (Satisfaction with postbasic opportunities) | $X^2 = 1.706$ | 1*df* | N.S. |
| Q9e | (Apron supplies) | $X^2 = 0.057$ | 1*df* | N.S. |
| Q12 | (Policy) | $X^2 = 0.191$ | 1*df* | N.S. |

***Q10i Wearing a plastic disposable apron to attend a patient with MRSA***

One significant result was obtained. Nurses with high scores were not concerned about risks of HAI to themselves (Q3)

$X^2 = 7.506$ 1*df* $p < 0.01$

No other results were significant:-

| | | | | |
|---|---|---|---|---|
| Q2a | (Risk to patients) | $X^2 = 2.541$ | 1*df* | N.S. |
| Q8a | (Postbasic opportunities) | $X^2 = 1.200$ | 1*df* | N.S. |
| Q8b | (Satisfaction with postbasic opportunities) | $X^2 = 0.332$ | 1*df* | N.S. |
| Q9e | (Apron supplies) | $X^2 = 0.307$ | 1*df* | N.S. |
| Q12 | (Policy) | $X^2 = 0.085$ | 1*df* | N.S. |

*Qr10j* ***Wearing overshoes to attend a patient with MRSA***

No significant results were obtained:-

| | | | | |
|---|---|---|---|---|
| Q2 | (Risk to patients) | $X^2 = 0.381$ | 1*df* | N.S. |
| Q3 | (Risk to self) | $X^2 = 0.568$ | 1*df* | N.S. |
| Q8a | (Postbasic opportunities) | $X^2 = 0.172$ | 1*df* | N.S. |
| Q8b | (Satisfaction with postbasic opportunities) | $X^2 = 0.593$ | 1*df* | N.S. |
| Q12 | (Policy) | $X^2 = 0.027$ | 1*df* | N.S. |

*Qr10k* ***Wearing a hair covering to attend a patient with MRSA***

All results were non-significant:-

| | | | | |
|---|---|---|---|---|
| Q2a | (Risk to patients) | $X^2 = 0.009$ | 1*df* | N.S. |
| Q3 | (Risk to self) | $X_2 = 0.055$ | 1*df* | N.S. |
| Q8a | (Postbasic opportunities) | $X^2 = 0.853$ | 1*df* | N.S. |
| Q8b | (Satisfaction with postbasic opportunities) | $X^2 = 0.475$ | 1*df* | N.S. |
| Q12 | (Policy) | $X^2 = 0.963$ | 1*df* | N.S. |

*Qr10l* ***Providing disposable crockery and cutlery for a patient with MRSA***

No significant results were obtained:-

| | | | | |
|---|---|---|---|---|
| Q2a | (Risk to patients) | $X^2 = 0.084$ | 1*df* | N.S. |
| Q3 | (Risk to self) | $X^2 = 0.000$ | 1*df* | N.S. |
| Q8a | (Postbasic opportunities) | $X^2 = 0.073$ | 1*df* | N.S. |
| Q8b | (Satisfaction with postbasic opportunities) | $X^2 = 0.118$ | 1*df* | N.S. |
| Q12 | (Policy) | $X^2 = 0.130$ | 1*df* | N.S. |

## Principles of Microbiology

*Qr12* ***Ability to name nosocomial pathogens***

No significant findings were obtained:-

| | | | | |
|---|---|---|---|---|
| Q2a | (Risk to patients) | $X^2 = 0.120$ | 1*df* | N.S. |
| Q3 | (Risk to self) | $X^2 = 2.187$ | 1*df* | N.S. |
| Q8a | (Postbasic opportunities) | $X^2 = 1.005$ | 1*df* | N.S. |
| Q8b | (Satisfaction with postbasic opportunities) | $X^2 = 0.014$ | 1*df* | N.S. |

*Qr13a* *Transmission of micro-organisms*

Nurses' knowledge of the transmission of micro-organisms was not related to their opinions of HAI expressed during interview:-

| | | | | |
|---|---|---|---|---|
| Q1 | (Prevalence of HAI) | $X_2 = 0.231$ | 1*df* | N.S. |
| Q2a | (Risk to patients) | $X^2 = 0.707$ | 1*df* | N.S. |
| Q3 | (Risk to self) | $X^2 = 0.217$ | 1*df* | N.S. |
| Q8a | (Postbasic opportunities) | $X^2 = 0.013$ | 1*df* | N.S. |
| Q8b | (Satisfaction with postbasic opportunities) | $X^2 = 0.070$ | 1*df* | N.S. |
| Q11 | (Sore, dry hands) | $X^2 = 1.400$ | 1*df* | N.S. |
| Q12 | (Policy) | $X^2 = 2.331$ | 1*df* | N.S. |

*Qr13b* *Identifying the chief mode of transmission of bacteria in hospital*

One significant result was obtained: nurses satisfied with postbasic opportunities scored well (Q8b)

$X^2 = 5.967$ 1*df* $p < 0.05$

No other results were significant:-

| | | | | |
|---|---|---|---|---|
| Q1 | (Prevalence of HAI) | $X_2 = 0.873$ | 1*df* | N.S. |
| Q2a | (Risk to patients) | $X^2 = 0.184$ | 1*df* | N.S. |
| Q3 | (Risk to self) | $X^2 = 0.172$ | 1*df* | N.S. |
| Q8a | (Postbasic opportunities) | $X^2 = 0.635$ | 1*df* | N.S. |
| Q9a | (Provision of gloves) | $X^2 = 0.184$ | 1*df* | N.S. |
| Q9b | (Supply of hand decontaminating agents) | $X^2 = 0.357$ | 1*df* | N.S. |
| Q9e | (Provision of aprons) | $X^2 = 0.026$ | 1*df* | N.S. |
| Q11 | (Sore, dry hands) | $X^2 = 1.067$ | 1*df* | N.S. |
| Q12 | (Policy) | $X^2 = 0.667$ | 1*df* | N.S. |

*Qr14* *Identifying portals of entry*

The following associations were explored, but results were not statistically significant:-

| | | | | |
|---|---|---|---|---|
| Q1 | (Prevalence of HAI) | $X_2 = 0.258$ | 1*df* | N.S. |
| Q2a | (Risk to patients) | $X^2 = 0.232$ | 1*df* | N.S. |

| | | | | |
|---|---|---|---|---|
| Q3 | (Risk to self) | | | |
| Q8a | (Postbasic opportunities) | $X^2 = 0.107$ | 1*df* | N.S. |
| Q8b | (Satisfaction with postbasic opportunities) | $X^2 = 0.196$ | 1*df* | N.S. |

***Qr15*** ***Identifying patients particularly susceptible to infection***

No results were significant:-

| | | | | |
|---|---|---|---|---|
| Q1 | (Prevalence of HAI) | $X_- = 3.287$ | 1*df* | N.S. |
| Q2a | (Risk to patients) | $X^2 = 0.016$ | 1*df* | N.S. |
| Q8a | (Postbasic opportunities) | $X^2 = 2.631$ | 1*df* | N.S. |
| Q8b | (Satisfaction with postbasic opportunities) | $X^2 = 0.697$ | 1*df* | N.S. |

***Qr16*** ***Ranking HAI in order of most frequent occurrence***

The following relationships were examined but failed to reach statistical significance:-

| | | | | |
|---|---|---|---|---|
| Q1 | (Prevalence of HAI) | $X^2 = 0.442$ | 1*df* | N.S. |
| Q8b | (Satisfaction with postbasic opportunities) | $X^2 = 3.381$ | 1*df* | N.S. |

***Qr17*** ***Distinction between the concepts of colonisation (carriage) and infection***

The following non-significant results were obtained:-

| | | | | |
|---|---|---|---|---|
| Q1 | (Prevalence of HAI) | $X_2 = 0.234$ | 1*df* | N.S. |
| Q2a | (Risk to patients) | $X^2 = 0.231$ | 1*df* | N.S. |
| Q3 | (Risk to self) | $X^2 = 0.797$ | 1*df* | N.S. |
| Q5 | (Concern about HBV) | $X^2 = 1.198$ | 1*df* | N.S. |
| Q6 | (Vaccination against HBV) | $X^2 = 0.012$ | 1*df* | N.S. |
| Q8a | (Postbasic opportunities) | $X^2 = 0.424$ | 1*df* | N.S. |
| Q8b | (Satisfaction with postbasic opportunities) | $X^2 = 0.157$ | 1*df* | N.S. |

***Qr18*** ***Differences between Gram positive and Gram negative bacteria***

The following non-significant results were obtained:-

| | | | | |
|---|---|---|---|---|
| Q8a | (Postbasic opportunities) | $X^2 = 0.550$ | 1*df* | N.S. |
| Q8b | (Satisfaction with postbasic opportunities) | $X^2 = 0.028$ | 1*df* | N.S. |

*Qr19a* ***Recognising body fluids which may transmit HIV***

The following non-significant results were obtained:

| | | | | |
|---|---|---|---|---|
| Q3a | (Risks to self) | $X^2 = 0.169$ | 1*df* | N.S. |
| Q8a | (Postbasic opportunities) | $X^2 = 3.160$ | 1*df* | N.S. |
| Q8b | (Satisfaction with postbasic opportunities) | $X^2 = 0.359$ | 1*df* | N.S. |
| Q12 | (Policy) | $X^2 = 2.731$ | 1*df* | N.S. |

*Qr19b* ***Recognising body fluids which may transmit HBV***

There were no statistically significant findings:-

| | | | | |
|---|---|---|---|---|
| Q3a | (Risks to self) | $X^2 = 1.106$ | 1*df* | N.S. |
| Q5 | (Concern about HBV) | $X^2 = 0.927$ | 1*df* | N.S. |
| Q6 | (Vaccination against HBV) | $X^2 = 1.081$ | 1*df* | N.S. |
| Q8a | (Postbasic opportunities) | $X^2 = 0.322$ | 1*df* | N.S. |
| Q8b | (Satisfaction with postbasic opportunities) | $X^2 = 0.004$ | 1*df* | N.S. |
| Q12 | (Policy) | $X^2 = 1.982$ | 1*df* | N.S. |

**Evaluation and Summary: the Knowledge Questionnaires**

Evaluation was considered in Chapter Five. Results are summarised here.

Nurses' knowledge overall was disappointing, particularly for contact precautions and theoretical principles. Scores for blood and body fluid precautions, contact precautions and theoretical principles were significantly higher in Hospital B. There was no association between any of the scores and the clinical setting in which they were obtained and, of the sociodemographic variables recorded, there was only one significant finding: knowledge of blood and body fluid precautions was greater for registered general nurses. However, some nurses were generally better informed than others, as those who scored well on one questionnaire tended to do well on the remainder.

No pattern emerged when knowledge and interview data or ward atmosphere were examined, but there was modest ($p$ <0.05) positive correlation between Likert and Knowledge scores. As both were significantly greater in Hospital B this could have been a reflection of the Hospital effect, so the association between these variables was further examined with ANOVA. For blood and body fluids precautions the association then held good only for hospital, but for theoretical principles the effect of opinion associated most significantly with knowledge.

When individual questions were examined it was possible to determine specific areas where knowledge was particularly unsatisfactory. Moreover, when scores for individual questions were compared it became apparent that in many cases the response to one question was not in many cases associated with response to others intended to measure related concepts. This supports the view that many nurses continue to hold irrational beliefs concerning some areas of infection control.

**Aim 4 To observe three essential elements of nurses' clinical infection control practice: hand decontamination, glove and sharps use.**

This involved the following comparisons:-

i. Two hospitals, one with, the other without an infection control nurse.

ii. Intensive care, surgical and medical units.

iii. Experienced and less experienced nurses.

**Results of Non-Participant Observation**

The pilot studies described in Chapter Five resulted in a method of observation which, subject to a few modifications chiefly related to sharps use, obtained the required data for the main study and proved acceptable to staff. Some data were inevitably missing. Two subjects did not decontaminate hands at all during the two hours they were observed, itself an important finding. One hundred and sixty-nine nurses washed hands (97.68%), but only seventy-eight (45.08%) used handrub. Gloves were worn by eighty-seven (50.2%) nurses and sharps disposed of by one hundred and forty-four (83.23%). The opportunity to recap needles after they had been used to inject a patient only arose in seventy (40.46%) cases: blood was taken without needles in ITU.

Observation was of a very close and detailed nature. Occasionally some aspects of hand decontamination were inevitably missed, though very seldom more than once for a particular nurse. For example, duration might not be timed or it might not be possible to observe which hand surfaces had been decontaminated. This occurred most often when decontamination was brief, especially when handrub was used, because episodes often happened swiftly, with less warning than when the nurse moved towards a sink.

The schedule proved a suitable instrument for rapidly recording events as they occurred by ticking boxes, but interpretation and scoring were impossible in the clinical situation owing to the speed of events.

It was essential to record contextual material accurately and in sufficient detail to make decisions during preliminary analysis. For example, it was not adequate to record "changed bedclothes". Details of soiling or bloodstains were necessary to determine whether gloves should have been worn.

The quantitative results of each aspect of hand decontamination, glove and sharps use are discussed below, beginning with the total number of clinical contacts (workload) as this was used to determine percentage frequency. In later sections material not amenable to statistical analysis is presented.

**Quantitative Results**

**Total Number of Clinical Contacts (Workload)**

**TABLE 6.40 Mean number of clinical contacts (workload)**

| | A | B | Both Hospitals |
|---|---|---|---|
| ITU | 30.03 | 25.57 | 27.80 |
| Surgical | 22.47 | 25.70 | 24.08 |
| Medical | 22.78 | 16.42 | 19.66 $n$ = 173 |
| All | 25.17 | 22.84 | 24.01 SD = 11.05 |

Mean number of clinical contacts per two hours was 24.01 (see Table 6.40).

Bivariate analysis suggested that workload was not significantly different between hospitals:-

W = 7985.5 $p$ <0.2064 N.S.

However, according to the Kruskal Wallis test, there was a difference between clinical settings, with most clinical contacts performed in ITU:-

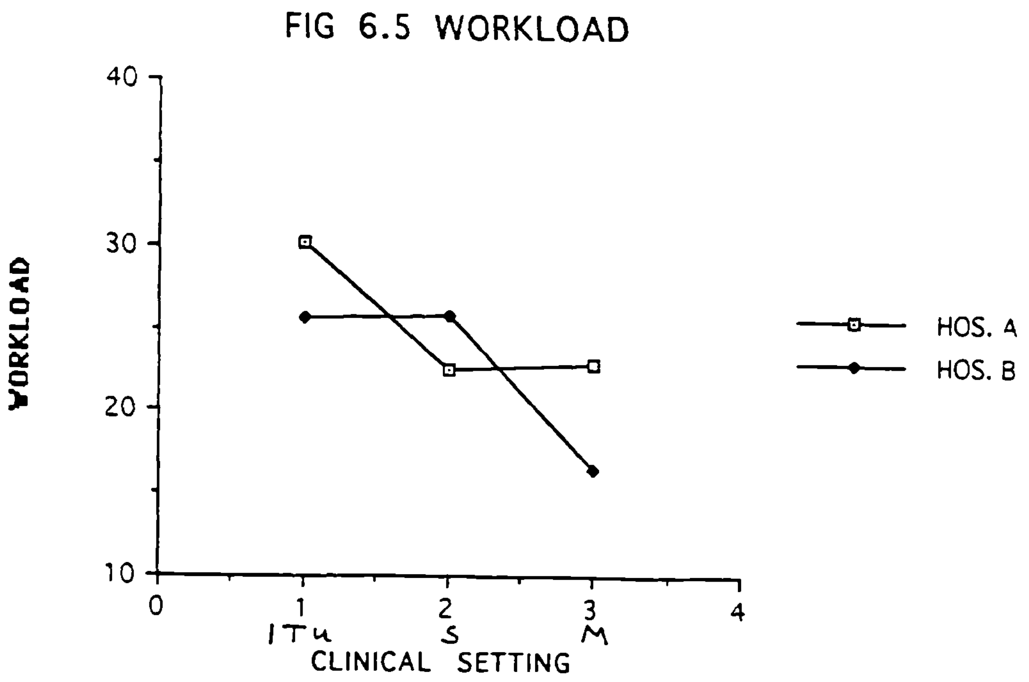
H = 15.64    2*df*    $p$ <0.000

ANOVA confirmed these findings, indicating that the hospital influenced the manner in which the clinical settings differed:-

| | | | |
|---|---|---|---|
| Hospital Effect | F (1, 173) = 2.53 | $p$ <0.113 | N.S. |
| Unit Effect | F (2, 173) = 8.69 | $p$ <0.000 | |
| Hospital/Unit Effect | F (2, 173) = 3.43 | $p$ <0.035 | |

Although significantly more clinical contacts were performed in ITU than medical and surgical wards, ITU in Hospital A was busier than ITU in Hospital B (see Figure 6.5).

**Figure 6.5 Workload**



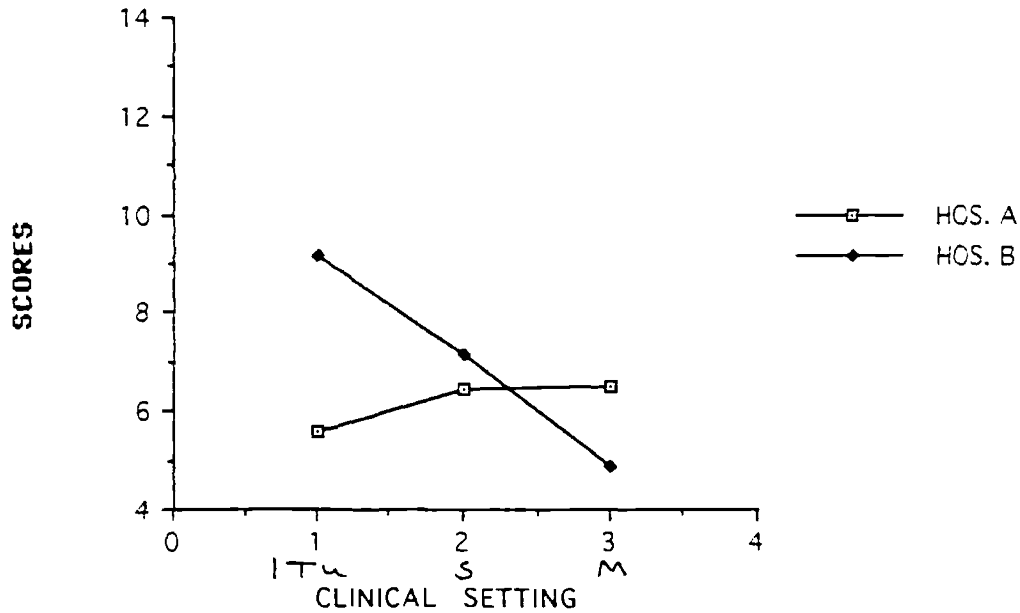
Standard deviation was 11.05 indicating considerable variation in workload. This was almost certainly influenced by clinical speciality. Workload was lightest on Ward 2, which admitted a high proportion of relatively fit patients for day surgery.

**Hand Decontamination**

**Rigor Score/Frequency of Decontamination**

Average decontamination frequency over two hours was 6.67 (28.78%) (see Figure 6.6a). Thus, throughout an eight hour shift, hands would be decontaminated an average of 26.68 times.

**Figure 6.6a Rigor Score**



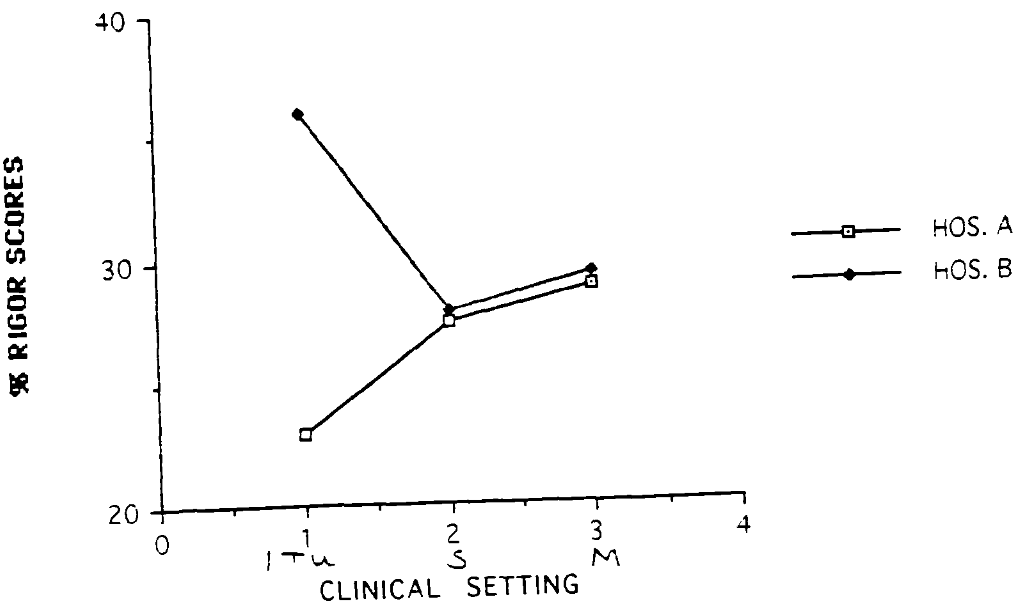

Two nurses omitted decontamination entirely, although the need arose for all. According to the results of bivariate analysis, performed on the raw data, frequency was no different between hospital or clinical setting:-

W = 7042.5     $p$ <0.1088    N.S.

H = 4.45   2$df$   $p$ <0.109    N.S.

However, percentage rather than raw frequencies are more illuminating (see Figure 6.6b).

**Figure 6.6b Rigor Scores - % Frequency of Decontamination**




This indicates that hands were decontaminated most often in ITU Hospital B and least often in ITU Hospital A (see Table 6.41). This result was further explored with ANOVA, to reveal a significant interactive effect between hospital and unit:-

| | | | |
|---|---|---|---|
| Hospital | $F (1, 171) = 0.91$ | $p < 0.343$ | N.S. |
| Unit | $F (2, 171) = 2.60$ | $p < 0.078$ | N.S. |
| Hospital/Unit | $F (2, 171) = 5.97$ | $p < 0.003$ | |

**TABLE 6.41 Rigor Score/Frequency of Decontamination**

| | A | | B | | Both Hospitals | |
|---|---|---|---|---|---|---|
| | Mean | % Frequency | Mean | % Frequency | Mean | % Frequency |
| ITU | 5.60 | 22.92 | 9.16 | 35.86 | 7.38 | 29.54 |
| Surgical | 6 46 | 27.3 | 7 13 | 27.76 | 6.80 | 28 36 |
| Medical | 6.50 | 28.79 | 4 88 | 29 34 | 5.73 | 29 01 $n$ = 171 |
| All | 6.19 | 24.64 | 7.16 | 31.35 | 6.67 | 28.78 SD = 3.99 |

**The Liberal Appropriateness Scheme for Hand Decontamination**

When essential decontaminations were considered frequency was 11.42 (49.85%) for the sample overall (see Table 6.42).

Bivariate analysis performed on the raw data revealed no difference between hospitals:-

W = 7978 $p$ <0.2141 N.S.

However, the result of a Kruskall Wallis test was significant:-

H = 8.68 2$df$ $p$ <0.013

Essential hand decontaminations were performed most often in ITU and least often on medical wards (see Table 6.42).

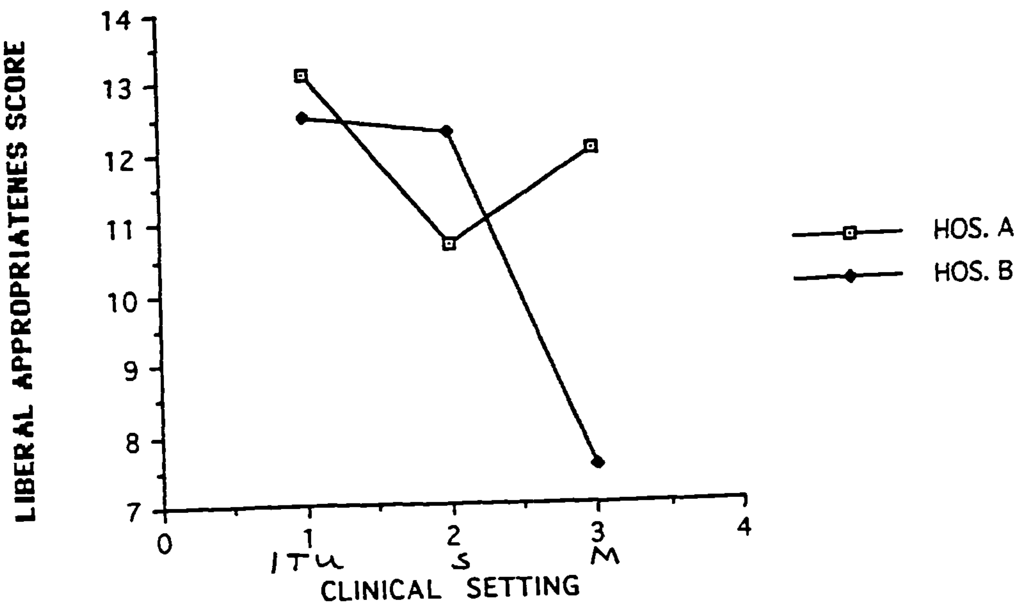
**TABLE 6.42 Results of the Liberal Appropriateness Score**

| | A | | B | | Both Hospitals | |
|---|---|---|---|---|---|---|
| | Mean | % Frequency | Mean | % Frequency | Mean | % Frequency |
| ITU | 13.1 | 35.37 | 12.5 | 64.27 | 12.80 | 49.48 |
| Surgical | 10.67 | 55.36 | 12.26 | 54.35 | 11.46 | 52.24 |
| Medical | 12 | 50.62 | 7 53 | 54.6 | 9 81 | 52 12 $n$ = 171 |
| All | 11.92 | 42.15 | 10.91 | 58.36 | 11.42 | 49 85 SD = 5 82 |

From Figure 6.7a it was evident that this effect was not consistent across units for the same clinical speciality in different hospitals, so ANOVA was performed:-

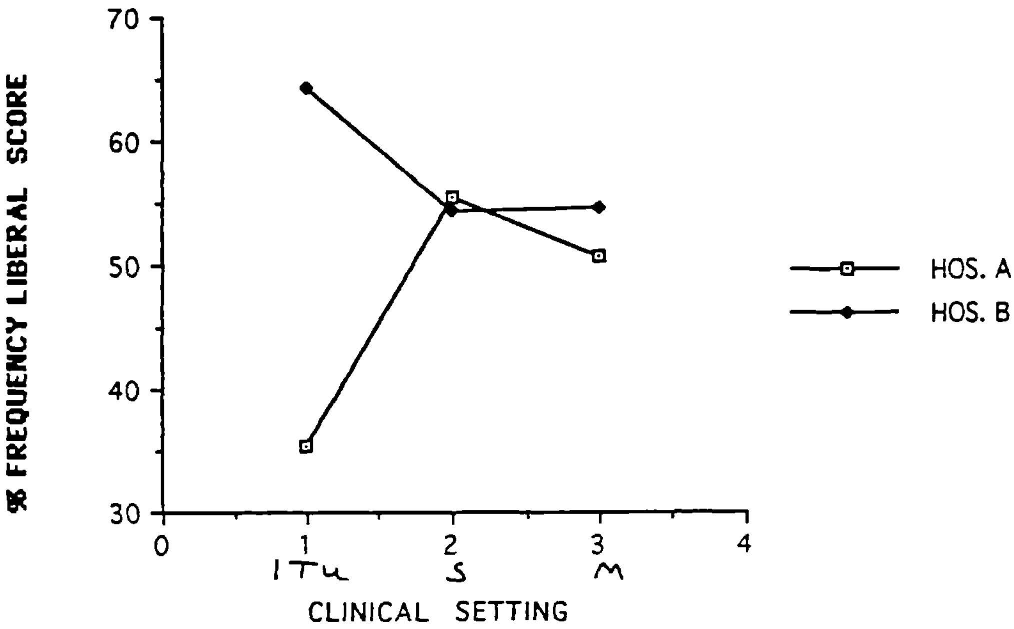
| | | | |
|---|---|---|---|
| Hospital | $F(2, 171) = 1.82$ | $p < 0.179$ | N.S. |
| Unit | $F(2, 171) = 4.10$ | $p < 0.018$ | |
| Hospital/Unit | $F(2, 171) = 4.16$ | $p < 0.017$ | |

**Figure 6.7a Results of the Liberal Appropriateness Score**




These results confirm that the hospital overall does not exert a significant effect on the Liberal Appropriateness Score, but the extent to which the unit exerts its influence is dependent upon whether it is in Hospital A or B. A higher percentage of essential decontaminations were performed in ITU Hospital B (see Figure 6.7b).

**Figure 6.7b % Frequency Liberal Score**




Frequency of hand decontamination on the Rigor Scheme and Liberal Appropriateness Score were very highly correlated according to the results of the Spearman's Rank correlation coefficient:-

$r_s = 0.635$ $p < 0.005$ $n = 171$

Clinical speciality on individual wards had some influence on the performance of essential decontamination. Scores were highest on Ward 7 where patients were nursed in isolation.

**Method of Hand Decontamination**

The frequencies with which handwashing and handrub use were performed are considered separately below.

**Handwashing Frequency**

Throughout the two hours observed, mean handwashing frequency was 4.84, with no significant difference between the hospitals or units (see Table 6.43).

W = 7722 $p$ <0.6413 N.S

H = 0.2900 *2df* $p$ <0.847 N.S.

**TABLE 6.43 Handwashing Frequency**

| | A | B | Both Hospitals |
|---|---|---|---|
| ITU | 4.73 | 5.1 | 4.8 |
| Surgical | 4.36 | 5.06 | 4.88 |
| Medical | 5.14 | 4.46 | 4.77 $n$ = 169 |
| All | 4.81 | 4.88 | 4.84 SD = 2.74 |

This finding was supported by the results of ANOVA:

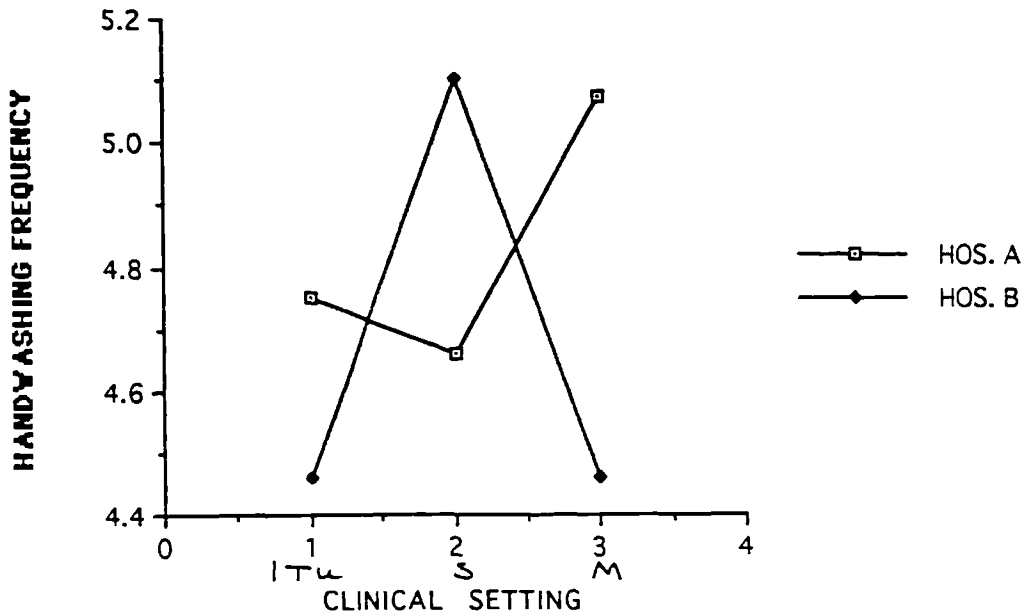
Hospital (F2, 161) = 0.01 $p$ = 0.91

Unit (F2, 161) = 0.39 $p$ = *0.675*

Hospital/Unit (F2, 169) = 0.56 $p$ = 0.572

Figure 6.8 indicates that pattern of handwashing frequency between clinical units was dissimilar between the two hospitals.

**Figure 6.8 Handwashing Frequency**




**Handrub Frequency**

Seventy-eight (45.08%) nurses used handrub, significantly more in Hospital B (see Table 6.44).

W = 6947 $p$ <0.0403

A Kruskall Wallis test was highly significant:-

H = 19.55 2$df$ $p$ <0.000

Handrub was most often used in ITU and least often in medical wards.

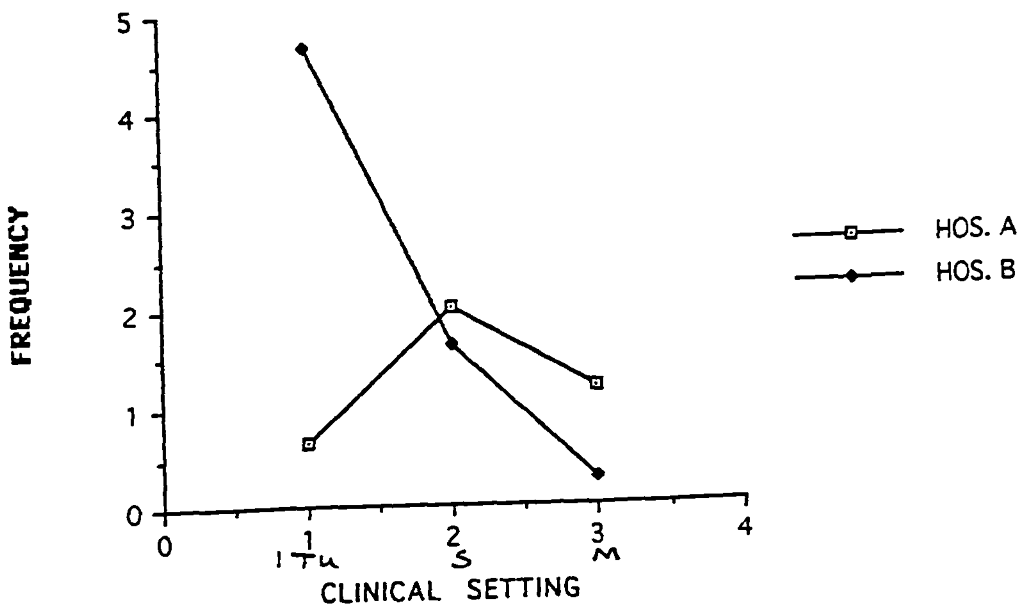
**TABLE 6.44 Frequency of Handrub Use**

| | A | B | Both Hospitals |
|---|---|---|---|
| ITU | 0.66 | 4.66 | 2.66 |
| Surgical | 2 | 1.63 | 1.81 |
| Medical | 1.18 | 0.26 | 0.73 $n$ = 78 |
| All | 1.28 | 2.27 | 1.78 SD = 2.74 |

From Figure 6.9 it was evident that uptake was not consistent for the same type of unit in different hospitals, so ANOVA was performed:-

| | | |
|---|---|---|
| Hospital | $F(2, 78) = 6.31$ | $p < 0.013$ |
| Unit | $F(2, 78) = 9.46$ | $p < 0.000$ |
| Hospital/Unit | $F(2, 78) = 18.89$ | $p < 0.000$ |

**Figure 6.9 Frequency of Handrub Use**




These results suggest that although both hospital and unit influence frequency of handrub use, the effect of the unit is most significant and from Table 6.44 it is apparent that use was heaviest in ITU, Hospital B. Two nurses used handrub exclusively: subject 41 (Ward 3) and subject 103 (ITU, Hospital B).

**Technique: The Components of Hand Decontamination**

Five components of handwashing were examined (choice of agent, number of surfaces decontaminated, duration, drying and disposal). Use of handrub consisted of three components: choice of agent, surfaces decontaminated and duration. Each will be presented below.

**Choice of Agent**

Appropriateness of agent was judged during preliminary analysis according to the criteria in Chapter Five. Overall, score for the sample was 11.11, with maximal score possible on two medical wards (5 and 14). Table 6.45 shows that scores were similar for the two hospitals:-

W = 6811 $p < 0.1973$ N.S.

However, the result of a Kruskal Wallis test was significant:-

H = 10.5 2*df* $p < 0.005$

**TABLE 6.45 Score for Choice of Agent**

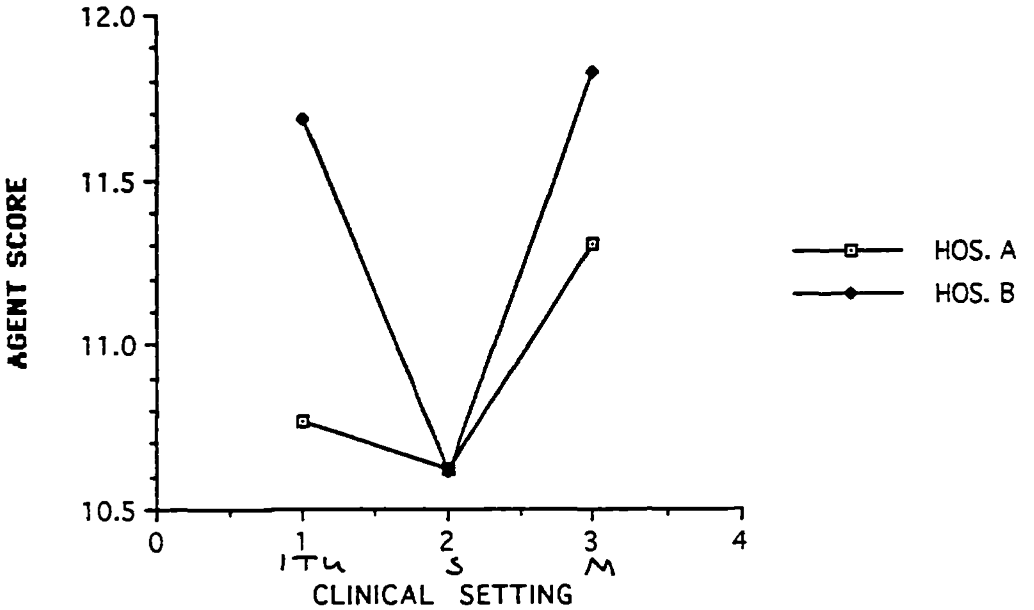
| | A | B | Both Hospitals |
|---|---|---|---|
| ITU | 10.77 | 11.68 | 11.22 |
| Surgical | 10.62 | 10.61 | 10.62 |
| Medical | 11.30 | 11.82 | 11.56 $n = 171$ |
| All | 10.88 | 11.34 | 11.11 SD = 1.82 |

Appropriate agents were most often used in medical wards and used least often in surgical wards, a finding confirmed by ANOVA.

| | | | |
|---|---|---|---|
| Hospital | F (1, 171) = 2.93 | $p < 0.089$ | N.S. |
| Unit | F (2, 171) = 4.02 | $p < 0.020$ | |
| Hospital/Unit | F (2, 171) = 0.99 | $p < 0.373$ | N.S. |

When the units in different hospitals were compared, patterns of behaviour were the same (Figure 6.10).

**Figure 6.10 Agent Score**




**Duration of Hand Decontamination**

**Duration of Handwashing**

The duration of handwashing was recorded as the time between contact of the agent with the hands until the commencement of rinsing, as recommended by *Quraishi et al (1984)* and *Larson and Lusk (1985)*. When no agent was applied, no score could be awarded. For the overall sample duration was 6.56 seconds. There was no significant difference between hospitals (see Table 6.46):-

W = 6887.5 $p$ <0.8972 N.S.

The result of the Kruskal Wallis test was highly significant: hands were washed longest in ITU and for the shortest duration on surgical wards (see Table 6.46):-

$H = 26.68 \quad 2df \quad p < 0.0000$

**TABLE 6.46 Handwashing Duration (Seconds)**

| | A | B | Both Hospitals |
|---|---|---|---|
| ITU | 9.19 | 7.35 | 8.29 |
| Surgical | 5.02 | 5.44 | 5.26 |
| Medical | 5.08 | 6.95 | 6.02 $n = 169$ |
| All | 6.58 | 6.55 | 6.56 SD = 3.77 |

These results are confirmed by ANOVA, which also demonstrated an interactive effect:-

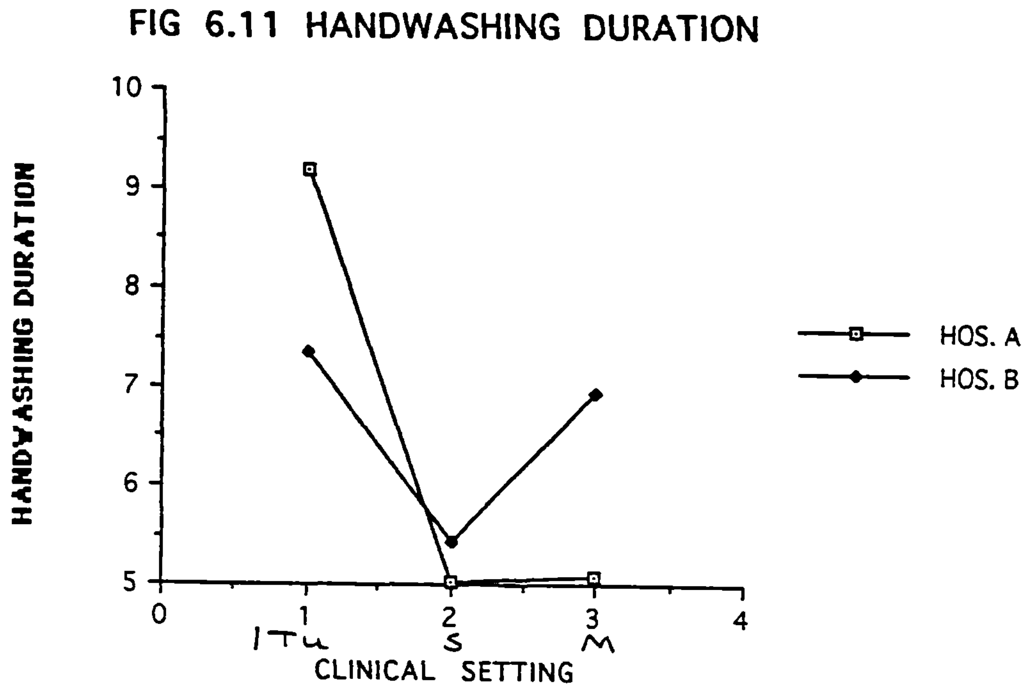
Hospital $F\ (1, 169) = 0.01$ $p < 0.918$ N.S.

Unit $F\ (2, 169) = 11.35$ $p < 0.0000$

Hospital/Unit $F\ (2, 169) = 3.92$ $p < 0.022$

Figure 6.11 illustrates that nurses employed within the same type of clinical setting but different hospitals followed the same pattern of behaviour.

**Figure 6.11 Handwashing Duration**




**Duration of Handrub Use**

When handrub was used, duration was calculated as the time between contact of the agent with the hands until massage ceased. Overall duration was 4.81 seconds, less than with conventional handwashing. There was no difference in scores between the two hospitals or three units (see Table 6.47).

| | | | |
|---|---|---|---|
| W = 834.5 | | $p$ <0.5194 | N.S. |
| H = 4.22 | 2*df* | $p$ <0.122 | N.S. |

This was confirmed by ANOVA:-

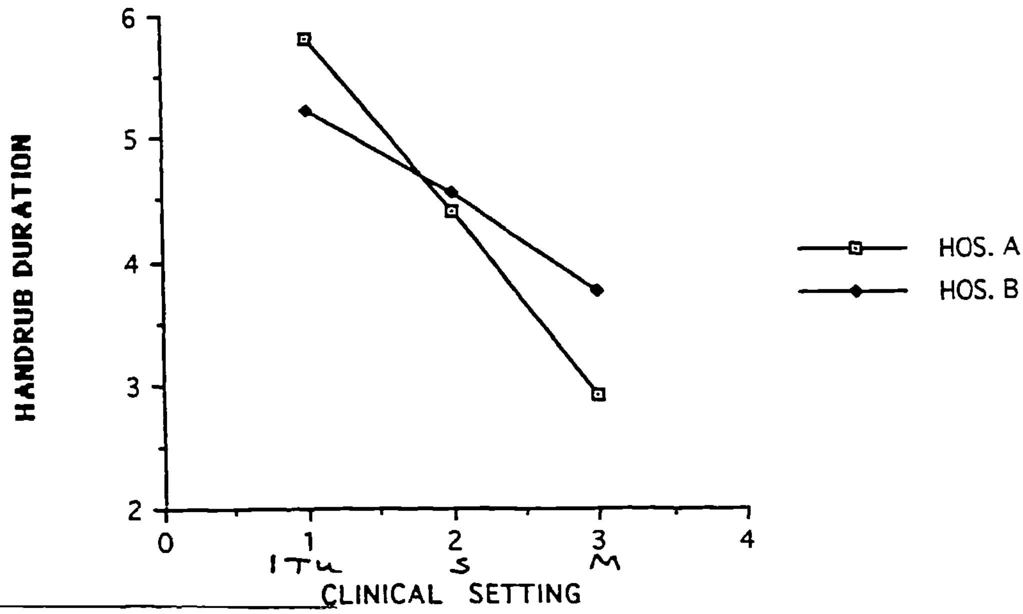
| | | | |
|---|---|---|---|
| Hospital | F (1, 78) = 0.03 | $p$ <0.867 | N.S. |
| Unit | F (2, 78) = 2.09 | $p$ <0.13 | N.S. |
| Hospital/Unit | F (2, 78) = 0.23 | $p$ <0.794 | N.S. |

**TABLE 6.47 Duration Score for Handrub**

| | A | B | Both Hospitals |
|---|---|---|---|
| ITU | 5.80 | 5.22 | 5.35 |
| Surgical | 4.41 | 4.56 | 4.49 |
| Medical | 2.9 | 3.75 | 3.27 $n$ = 78 |
| All | 4.68 | 4.93 | 4.81 SD = 2.9 |

Patterns of behaviour were the same for nurses employed within the same clinical setting but different hospitals (see Figure 6.12).

Figure 6.12 Handrub Duration



**Number of Hand-Surfaces Decontaminated (Surfaces Score)**

**Surfaces Score for Handwashing**

Employing the criteria shown in Chapter Five, surfaces score was 8.58 overall with no significant difference between hospitals:-

W = 6954 $p < 0.6246$ N.S.

The result of a Kruskal Wallis test was significant (see Table 6.48).

H = 10.08 $2df$ $p < 0.007$

Handwashing was more thorough on ITU and least thorough on surgical wards.

TABLE 6.48 Surfaces Score for Handwashing

| | A | B | Both Hospitals |
|---|---|---|---|
| ITU | 9.48 | 9.06 | 9.28 |
| Surgical | 8.20 | 7.97 | 8.08 |
| Medical | 8.18 | 8.48 | 8.33 $n = 169$ |
| All | 8.66 | 8.58 | 8.58 SD = 2.09 |

These results are confirmed by ANOVA:-

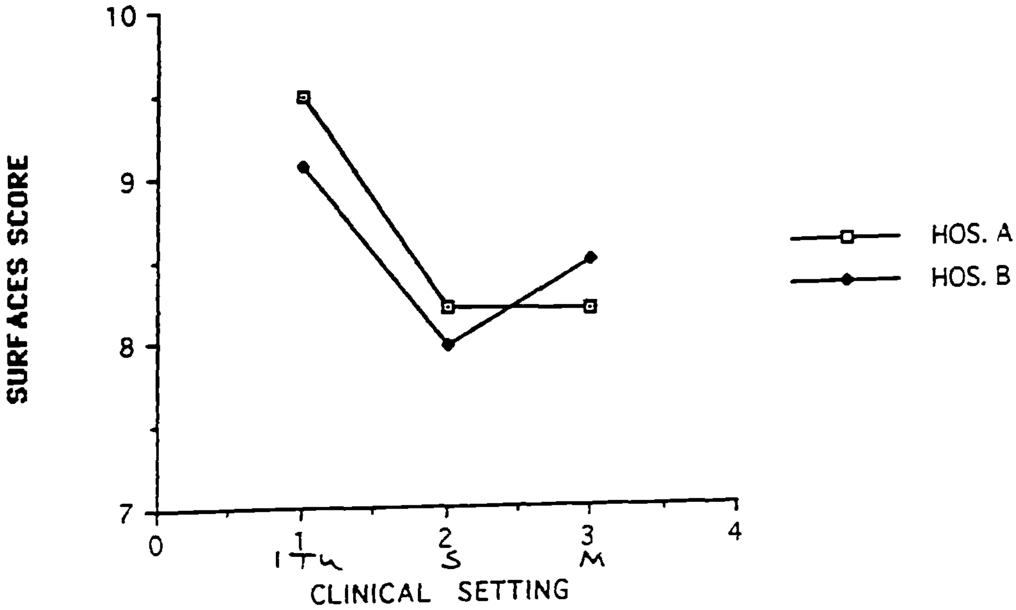
Hospital F (1,169) = 0.18 $p < 0.674$ N.S.

Unit F (2, 169) = 5.37 $p < 0.006$

Hospital/Unit F (2, 169) = 0.44 $p < 0.643$ N.S.

Patterns of behaviour were not the same for nurses in the same clinical setting but different hospitals (see Figure 6.13). The surface most frequently omitted was the interdigital surface.

**Figure 6.13 Handwashing: Surfaces Score**




**Surfaces Score for Handrub Use**

When handrub was used surfaces score for the overall sample was 8.66, with no difference between hospital or unit (see Table 6.49). Again, the interdigital surface was most frequently omitted.

| | | | |
|---|---|---|---|
| W = 1336 | | $p$ <0.8111 | N.S. |
| H = 4.89 | $2df$ | $p$ <0.087 | N.S. |

This was confirmed by ANOVA:-

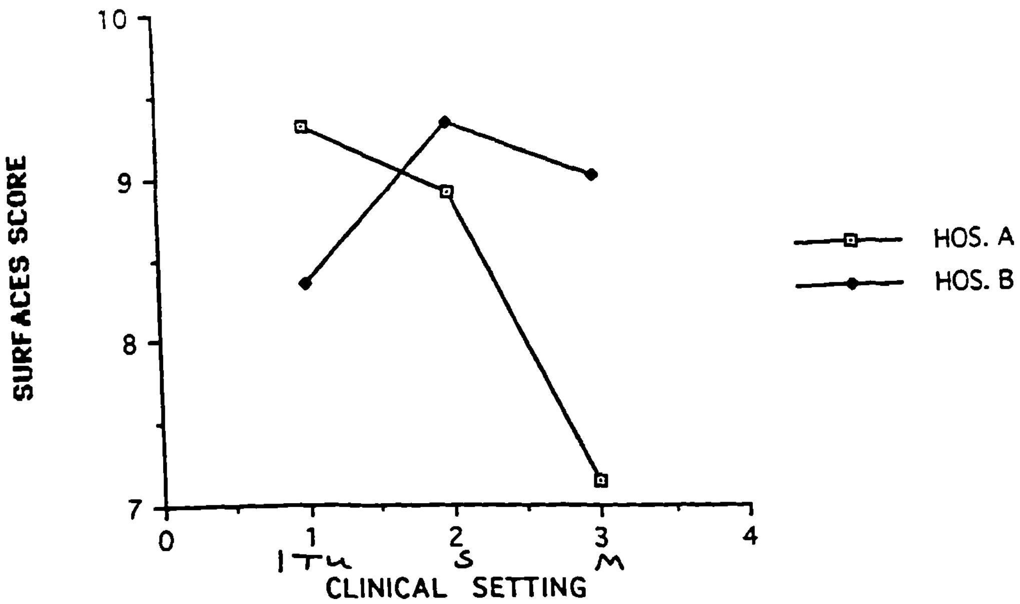
| | | | |
|---|---|---|---|
| Hospital | F (1, 78) = 0.84 | $p$ <0.362 | N.S. |
| Unit | F (2, 78) = 1.32 | $p$ <0.275 | N.S. |
| Hospital/Unit | F (2, 78) = 0.44 | $p$ <0.070 | N.S |

**TABLE 6.49 Surfaces Score for Handrub**

| | A | B | Both Hospitals |
|---|---|---|---|
| ITU | 9.3 | 8.34 | 8.58 |
| Surgical | 8.9 | 9.32 | 9.08 |
| Medical | 7.14 | 9 | 7.71 $n$ = 78 |
| All | 8.55 | 8.65 | 8.86 SD = 1.84 |

Pattern of behaviour varied according to the hospital in which the unit was situated (see Figure 6.14).

Figure 6.14 Handrub: Surfaces Score



**Drying**

Drying score overall was 9.51, with no difference between hospitals:-

W = 6692 $p$ <0.7086 N.S.

The result of a Kruskal Wallis test was significant (see Table 6.50).

H = 9.34 2$df$ $p$ <0.010

Nurses in ITU dried hands most thoroughly.

**TABLE 6.50 Drying Score**

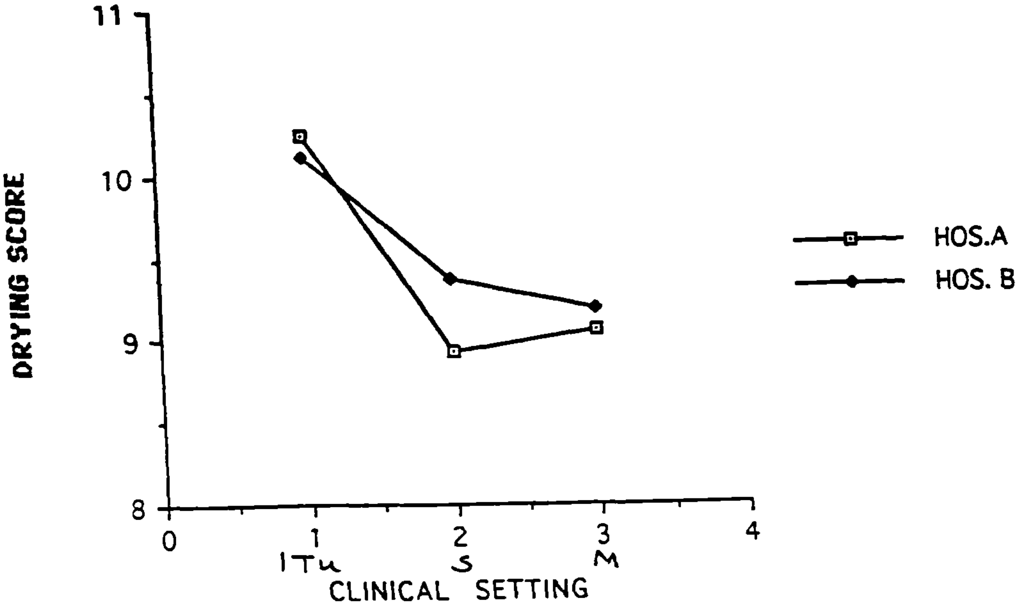
| | A | B | Both Hospitals |
|---|---|---|---|
| ITU | 10.24 | 10.10 | 10.17 |
| Surgical | 8.93 | 9.37 | 9.16 |
| Medical | 9.06 | 9.19 | 9.13 $n$ = 169 |
| All | 9.45 | 9.57 | 9.51 SD = 2.03 |

These results are confirmed by ANOVA:-

| | | | |
|---|---|---|---|
| Hospital | F (1, 169) = 0.19 | $p$ <0.662 | N.S. |
| Unit | F (2, 169) = 5.12 | $p$ <0.007 | |
| Hospital Unit | F (2, 169) = 0.30 | $p$ <0.739 | |

Patterns of behaviour were not the same for nurses in similar clinical settings but different hospitals (see Figure 6.15). However, examination of the raw data showed that many nurses scored maximally on this component of hand decontamination and there was no record of drying being omitted.

**Figure 6.15 Drying Score**




**Disposal**

Disposal score was 9.12 for the total sample, with no significant difference between hospitals:-

W = 6291.5 $p$ <0.1342 N.S.

However, the result was highly significant when units were examined:-

H = 22.59 2*df* $p$ <0.0000

ITU nurses were least likely to recontaminate hands (see Table 6.51).

**TABLE 6.51 Disposal Score**

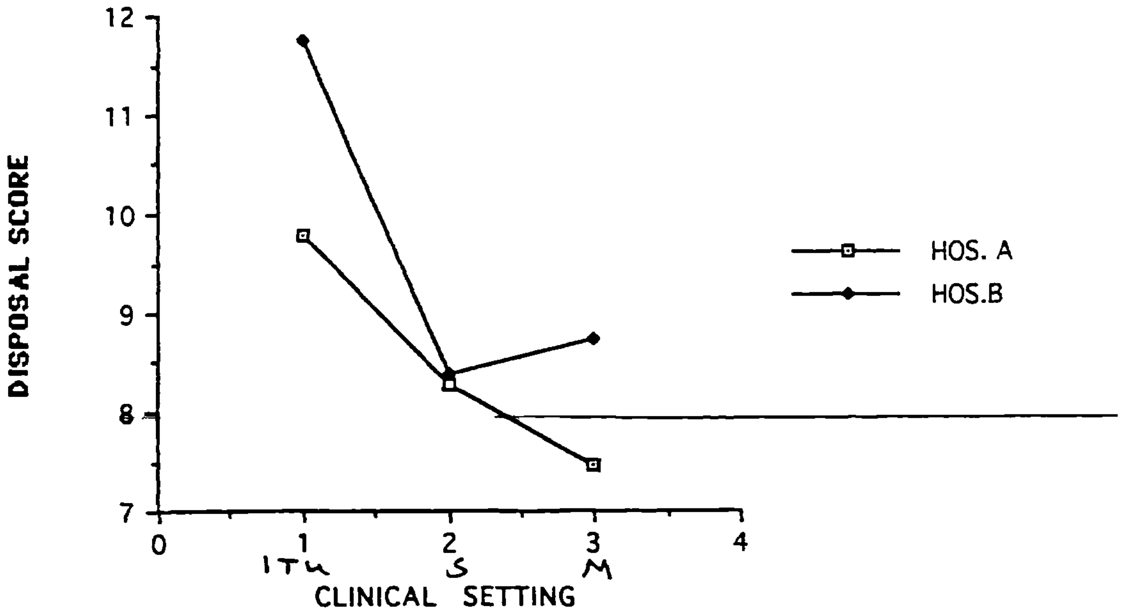
| | A | B | Both Hospitals |
|---|---|---|---|
| ITU | 9.78 | 11.77 | 10.78 |
| Surgical | 8.27 | 8.37 | 8.32 |
| Medical | 7.45 | 8.74 | 8.10 $n$ = 169 |
| All | 8.56 | 9.66 | 9.12 SD = 3.81 |

These results are partially confirmed by ANOVA: here the hospital effect just reaches significance while, as above, clinical setting is highly significant:-

| | | |
|---|---|---|
| Hospital | $F(1, 169) = 4.04$ | $p < 0.046$ |
| Unit | $F(2, 169) = 9.64$ | $p < 0.000$ |
| Hospital/Unit | $F(2, 169) = 1.000$ | $p < 0.371$ |

Patterns for behaviour for nurses within the same clinical setting but different hospitals are not similar (see Figure 6.16).

**Figure 6.16 Disposal Score**



**The relationship between different components of hand decontamination**

The possible association between each of the five components of handwashing and the three components of handrub use were examined by performing Spearman's Rank Correlation Coefficient.

**Handwashing**

| | | | |
|---|---|---|---|
| Duration and Surfaces Score | $r_s = 0.711$ | $p < 0.005$ | $n = 169$ |
| Duration and Disposal Score | $r_s = 0.290$ | $p < 0.005$ | $n = 169$ |
| Duration and Drying Score | $r_s = 0.306$ | $p < 0.005$ | $n = 169$ |
| Surfaces Score and Disposal Score | $r_s = 0.296$ | $p < 0.005$ | $n = 169$ |
| Surfaces Score and Drying Score | $r_s = 0.313$ | $p < 0.005$ | $n = 169$ |
| Drying Score and Disposal Score | $r_s = 0.211$ | $p < 0.05$ | $n = 169$ |
| Agent and Duration Score | $r_s = 0.050$ | N.S. | $n = 169$ |
| Agent and Drying Score | $r_s = 0.018$ | N.S. | $n = 169$ |
| Agent and Disposal Score | $r_s = 0.035$ | N.S. | $n = 169$ |
| Agent and Surfaces Score | $r_s = 0.088$ | N.S. | $n = 169$ |

Four of the handwashing components, duration, drying, surfaces and disposal correlated positively, but choice of agent correlated significantly with none of the other scores.

On this basis it is reasonable to assume that a nurse who performed well on one of the components of handwashing would also do so on the others, with the exception of choosing the most appropriate agent. It was therefore possible to calculate an overall score for handwashing technique, the Amalgamated Handwashing Score, from which data related to choice of agent were omitted. Data used to calculate duration were adjusted (see Appendix 6).

The results of the Amalgamated Handwashing Score were correlated with individual components of the score to ensure that agreement occurred. Again, all results were significant except choice of agent:-

| | | | |
|---|---|---|---|
| Drying | $r_s = 0.564$ | $p < 0.001$ | $n = 169$ |
| Duration | $r_s = 0.744$ | $p < 0.001$ | $n = 169$ |
| Surfaces | $r_s = 0.751$ | $p$ (0.001 | $n = 169$ |
| Disposal | $r_s = 0.715$ | $p < 0.001$ | $n = 169$ |
| Agent | $r_s = 0.030$ | N.S. | $n = 169$ |

**Results of the Amalgamated Handwashing Score**

Mean Amalgamated Handwashing Score was 8.64, with no significant difference between hospitals:-

$W = 6613$ $p < 0.2511$ N.S.

However, there was a highly significant difference between clinical settings:-

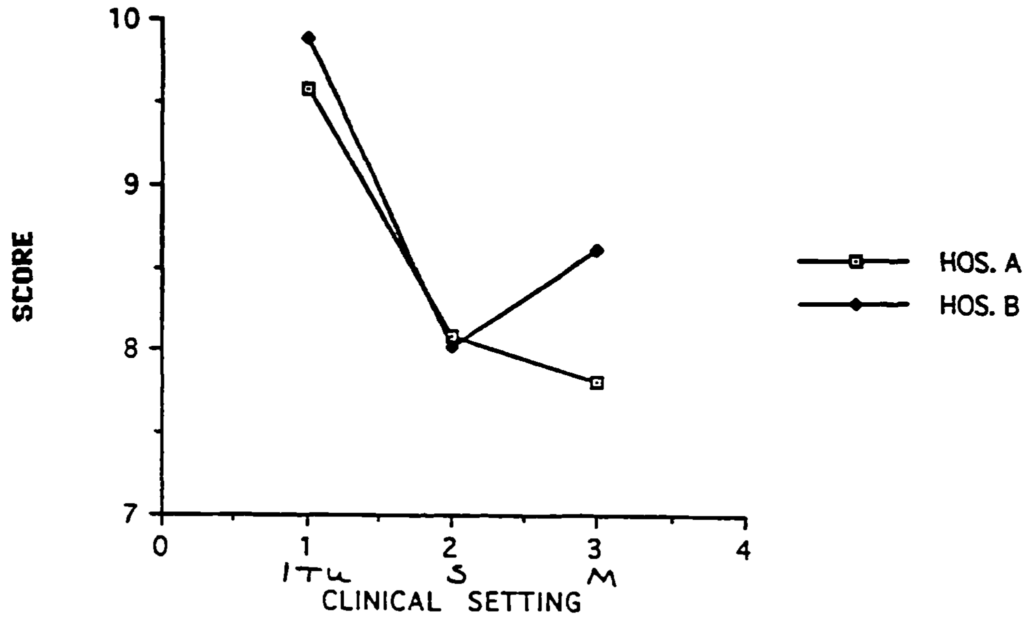
$H = 29.81$ $2df$ $p < 0.0000$

ITU nurses performed handwashing most effectively (see Table 6.52 and Figure 6.17)

**TABLE 6.52 The Results of the Amalgamated Handwashing Score**

| | A | B | Both Hospitals |
|---|---|---|---|
| ITU | 9.58 | 9.88 | 9.73 |
| Surgical | 8.08 | 8.02 | 8.04 |
| Medical | 7.81 | 8.60 | 8.21 $n = 169$ |
| All | 8.44 | 8.83 | 8.64 SD = 1.83 |

**Figure 6.17 Amalgamated Handwashing Score**




ANOVA confirms these results. Clinical setting influenced how well the handwashing technique was performed.

| | | | |
|---|---|---|---|
| Hospital | $F(1, 169) = 2.51$ | $p < 0.115$ | N.S. |
| Unit | $F(2, 169) = 17.48$ | $p < 0.000$ | |
| Hospital/Unit | $F(2, 169) = 0.39$ | $p < 0.677$ | N.S. |

**Relationship between Frequency and Technique of Handwashing**

The results of Spearman's Rank Correlation Coefficient indicated that frequency of handwashing was not related to performance of technique:-

Amalgamated Score and total number of handwashes on the Rigor Score:-

$r_s = 0.030$ N.S. $n = 169$

Amalgamated Score and Liberal Appropriateness Score:-

$r_s = 0.025$ N.S. $n = 169$

Individual components of technique were also examined in conjunction with frequency:-

Handwashing duration and total number of handwashes (Rigor Score):-

$r_s = 0.062$ N.S. $n = 169$

Handwashing duration and essential handwashes:-

$r_s = -0.047$ N.S. $n = 169$

Handwashing surfaces and total number of handwashes:-

$r_s = -0.059$ N.S. $n = 169$

Handwashing surface and essential handwashes:-

$r_s = -0.036$ N.S. $n = 169$

Drying and total number of handwashes:-

$r_s = 0.013$ N.S. $n = 169$

Drying and essential handwashes:-

$r_s = 0.008$ N.S. $n = 171$

No significant results were obtained.

**Relationship between Frequency and Choice of Agent**

Total number of hand decontaminations (Rigor Score) and agent:-

$r_s = -0.118$ N.S. $n = 169$

Liberal Appropriateness Score and Agent:-

$r_s = -0.173$ $p < 0.05$ $n = 169$

As score for choice of agent increased, fewer essential decontaminations were performed.

**The relationship between the different components of handrub use**

Results of the Spearman's Rank Correlation Coefficient suggested that duration of handrub application was not associated with the number of surfaces decontaminated or choice of agent, so these components could not be combined into an overall score:-

$r_s = 0.148$ N.S. $n = 78$

$r_s = -0.174$ N.S. $n = 78$

**Relationship between frequency and technique of handrub use**

Handrub surfaces score and total number of hand decontaminations (Rigor Score):-

$r_s = -0.271$ $p < 0.005$ $n = 78$

Handrub duration and Rigor Score:-

$r_s = -0.052$ N.S. $n = 78$

Handrub surfaces score and Liberal Appropriateness Score for handrubs:-

$r_s = -0.005$ N.S. $n = 78$

Handrub duration and Liberal Appropriateness Score for hanrubs:-

$r_s = 0.024$ N.S. $n = 78$

Handrub frequency and choice of agent:-

$r_s = -0.144$ N.S. $n = 78$

One significant result was obtained: as frequency of handrub use (Rigor Score) increased, fewer surfaces were decontaminated.

**Relationship between the common components of handwashing and handrub use**

Duration W = 21378 $p < 0.0004$

Surface Scores W = 20254.5 $p < 0.9359$ N.S.

Nurses' handwashing and handrub duration were significantly different (1.75 seconds, longer on average when handwashing was performed). However, number of surfaces decontaminated was the same regardless of agent.

**Glove Use**

**Need to wear gloves**

Gloves were needed approximately twice per two hours for the sample overall (see Table 6.52 and Figure 6.18). There was no difference between hospitals, but need was significantly greater in ITU:-

W = 7988 $p < 0.0841$ N.S.

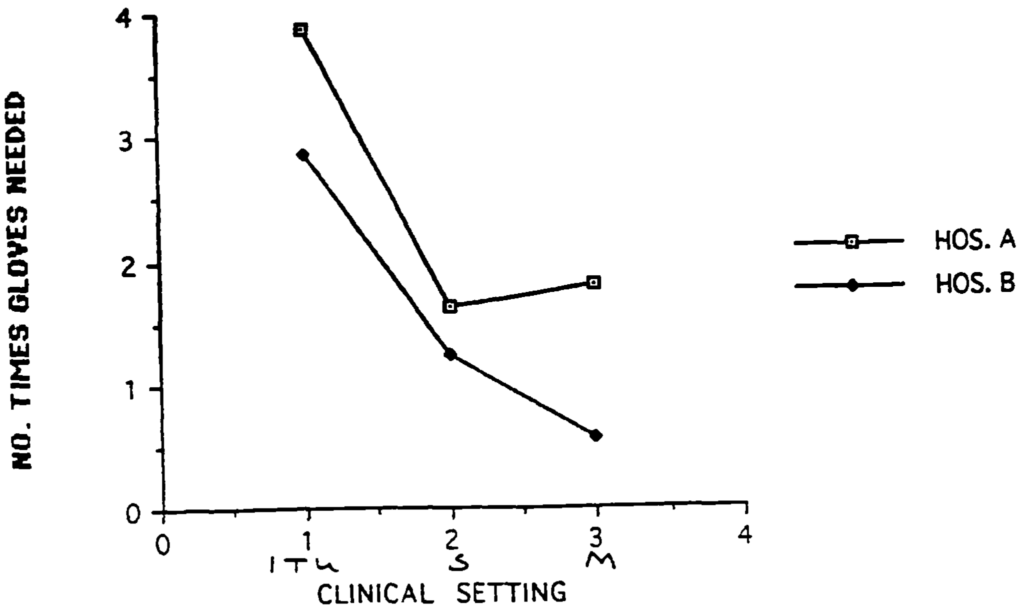
H = 31.14 2*df* $p < 0.000$

It was impossible to perform ANOVA as numbers were too small

**TABLE 6.53 Number of times gloves were needed during the two hours observation for all nurses**

| | A | B | Both Hospitals |
|---|---|---|---|
| ITU | 3.86 | 2.86 | 3.36 |
| Surgical | 1.63 | 1.23 | 1.43 |
| Medical | 1.80 | 0.57 | 1 $n = 113$ |
| All | 2.46 | 1.6 | 2.03 SD = 2.58 |

**Figure 6.18 Number of times gloves were needed**




ITU nurses required gloves chiefly to protect themselves when handling blood and body fluids and to protect both themselves and patients during endotracheal suction.

Of the general wards gloves were most often required on Ward 7, because of the large number of patients nursed in protective isolation.

## Number of occasions when gloves were worn

Gloves were generally worn less seldom than required (see Table 6.54). Again, there was no significant difference between the hospitals, but gloves were worn more often in ITU:-

W = 7262.5 $p < 0.8764$ N.S.

H = 48.34 $2df$ $p < 0.0000$

**TABLE 6.54 Occasions when gloves were worn during the two hours observation for all nurses**

| | A | B | Both Hospitals |
|---|---|---|---|
| ITU | 2.76 | 2.9 | 2.83 |
| Surgical | 0.75 | 0.83 | 0.79 |
| Medical | 0.38 | 0.38 | 0.38 N = 87 |
| All | 1.35 | 1.45 | 1.4 SD = 2.07 |

Again, numbers were too small for ANOVA.

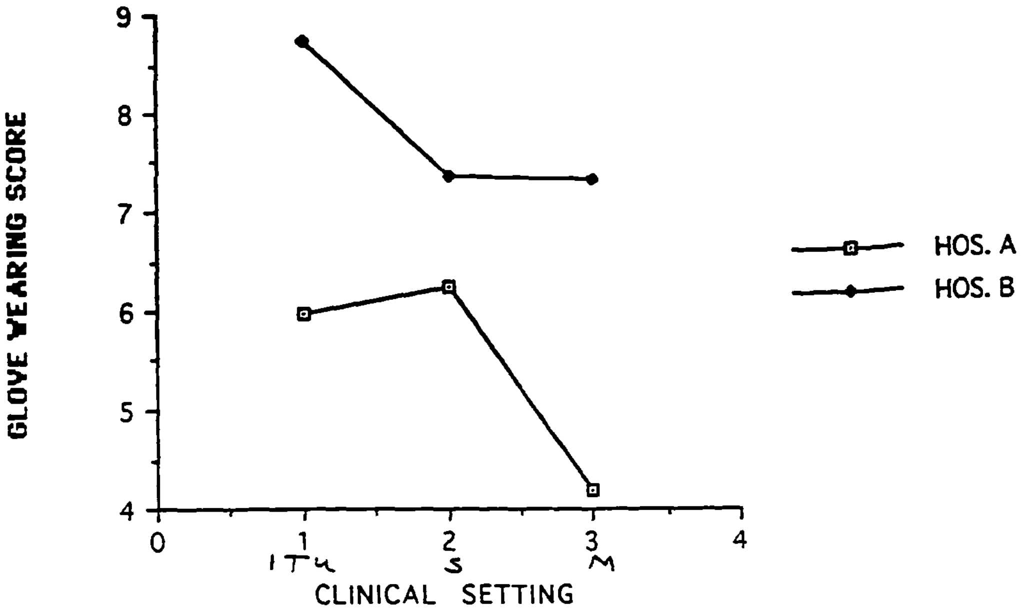
## Glovewearing Score

Glovewearing score was determined as in Chapter Five, but in a few additional cases aesthetic considerations governed the researcher's judgement: on ITU in Hospital A nurses were felt to wear gloves appropriately when withdrawing foul naso-gastric aspirate, although according to the criteria they should not be necessary for this procedure.

Glovewearing score was 6.71 for the total sample, with significantly higher scores in Hospital B (see Figure 6.19):-

W = 3202 $p < 0.0088$

Figure 6.19 Glove Wearing Score




Scores were similar on all three units (see Table 6.55).

H = 2.00    2*df*    $p$ <0.368    N.S.

TABLE 6.55 Glovewearing Score

| | A | B | Both Hospitals |
|---|---|---|---|
| ITU | 5.98 | 8.74 | 7.34 |
| Surgical | 6.25 | 7.36 | 6.76 |
| Medical | 4.18 | 7.33 | 5.32 $n$ = 113 |
| All | 5.61 | 8.05 | 6.71 SD = 4.82 |

This result is confirmed by ANOVA. Hospital infuenced this score.

| | | | |
|---|---|---|---|
| Hospital | $F(1, 113) = 6.21$ | $p < 0.014$ | |
| Unit | $F(2, 113) = 0.94$ | $p < 0.394$ | N.S. |
| Hospital/Unit | $F(2, 113) = 0.45$ | $p < 0.641$ | N.S. |

**Inappropriate Glovewearing**

According to the criteria presented in Chapter Five, inappropriate glovewearing was low for this sample (see Table 6.55). There was no difference between hospitals:-

W = 7387.5 $p < 0.7291$ N.S.

However, the result of a Kruskal Wallis test was highly significant:-

H = 22.69 2*df* $p < 0.000$

ITU Nurses were much more likely to wear gloves inappropriately.

**TABLE 6.56 Inappropriate Glovewearing over two hours for the 173 nurses**

| | A | B | Both Hospitals |
|---|---|---|---|
| ITU | 0.9 | 0.46 | 0.68 |
| Surgical | 8.13 | 0.10 | 0.11 |
| Medical | 0 | 0.15 | 0.07 $n = 32$ |
| All | 0.36 | 0.25 | 0.3 SD = 0.77 |

These results are confirmed by ANOVA:-

| | | |
|---|---|---|
| Hospital | $F(1, 32) = 1.13$ | $p < 0.289$ |
| Unit | $F(2, 32) = 12.60$ | $p < 0.000$ |
| Hospital/Unit | $F(2, 32) = 2.45$ | $p < 0.089$ |

Gloves were never worn inappropriately on three wards in Hospital B (5, 6, 7).

**Relationships between glove use and hand decontamination**

According to the results of Spearman's Rank Correlation Coefficient, nurses with high glovewearing scores were more likely to apply handrub to all hand surfaces.

$r_s = 0.96$ $p < 0.005$ $n = 78$

No other results were significant.

Glovewearing score and agent:-

$r_s = -0.098$ N.S. $n = 87$

Glovewearing score and Amalgamated Handwashing Score:-

$r_s = 0.020$ N.S. $n = 87$

Glovewearing score and duration of handrub application:-

$r_s = -0.025$ N.S. $n = 78$

Glovewearing and Rigor Score:-

$r_s = 0.044$ N.S. $n = 87$

Glovewearing score and Liberal Appropriateness Score:-

$r_s = -0.071$ $n = 87$

**Other Issues Related to Glove Use**

Non-specific glovewearing as described by *Stringer et al (1991)* was observed once. Subject 110 (ITU, Hospital B) wore the same gloves for a range of clean and dirty activities over a 15-minute period. Originally they were used to clean the inner tube of a tracheostomy, but these activities were interspersed with checking the patient and handling equipment in his immediate environment. The gloves were not removed when additional equipment was fetched. The patient was stable and the nurse was not busy to judge from demeanour or workload ($n$ = 16 clinical contacts).

Glove washing, which does not efficiently remove pathogens (*Doebbeling et al, 1988)*, was observed once by one subject (116, ITU Hospital B). Splitting and puncturing described by *Korneiwicz (1989)* and *Dalgleish and Malkovsky (1987)* were never observed.

## Sharps Use

### Frequency of Sharps Use

Considered for the sample overall, the mean frequency of sharps use was 0.94 (see Table 6.57), with a range of 1-5 for one hundred and forty-four nurses.

TABLE 6.57 Sharps Use: Frequency over two hours for the total sample

| | A | B | Both Hospitals |
|---|---|---|---|
| ITU | 0.62 | 1.17 | 0.89 |
| Surgical | 0.89 | 0.66 | 0.77 |
| Medical | 0.88 | 1.50 | 1.19 $n$ = 144 |
| All | 0.79 | 1.12 | 0.94 SD = 1.35 |

Frequency was similar across hospitals and clinical settings:-

W = 0.6181 $p$ <0.7764 N.S.

H = 2.61 2$df$ $p$ <0.272 N.S.

### Safe Sharps Disposal

The original criteria developed for safe sharps disposal (see Chapter Five) had to be extended as data collection progressed. ~~Throwing a razor across a room into a sharps box was not judged safe~~ and scored 0 (Subject 156, Ward 12).

Disposal into an open pot at the bedside (Subject 164, Ward 13) was not considered safe, as spillage could easily have occurred and the individual who eventually removed the accumulated sharps would be obliged to handle them needlessly. When a nurse cleared away sharps obviously left around by somebody else this was excluded from data collection, as disposal was considered the responsibility of the user. Apart from these lapses, every nurse who used a sharp instrument disposed of it correctly and as the few exceptions would skew results and make calculations invalid through low numbers, no further statistical analysis was attempted.

### Safe Sharps Handling

Safe sharps handling involved leaving needles uncapped before disposal (*Wormser et al, 1984*). Needles were recapped on three occasions, once on Ward 6 and twice by the same nurse on Ward 7. As in the case of safe sharps disposal, further statistical analysis was impractical.

### Incidents of Very Poor Practice (IVPP)

IVPP were recorded as any incident of outstandingly poor or unaesthetic practice witnessed by the nurse being observed, during the time of observation.

Ten events were recorded:-

| | | |
|---|---|---|
| Subject 26 | Drew up drug for intravenous injection. Left the syringe lying on the clinical surface then sucked the end as though it was a pencil. | (ITU, Hospital A) |
| Subject 36 | Hands in sharps bin. | (Ward 3, Hospital A) |
| Subject 40 | Pen inserted in sharps bin, then handled pen (risk of blood and body fluid contamination). | (Ward 3, Hospital A) |
| Subject 65 | Faeces thrown down sink with splashing (full operational bedpan washer available next to sink). | (Ward 5, Hospital A) |
| Subject 85 | Entered room for isolated, immunocompromised patient without wearing gloves or using handrub. | (Ward 7, Hospital A) |
| Subject 104 | Blood-stained apparatus left on clinical surface for over an hour | (ITU, Hospital B) |
| Subject 106 | Urine-soaked napkin left on clinical surface. | (ITU, Hospital B) |
| Subject 116 | Hand in sharps bin. | (ITU, Hospital B) |
| Subject 123 | Hand in sharps bin. | (Ward 9,Hospital B) |
| Subject 141 | Removed gloves with teeth after performing dressing (they had stuck to adhesive tape fastening the dressing). | (Ward 11, Hospital B) |

Of these ten incidents, four specifically involved incorrect handling of sharps after they had been discarded by someone else. One incident (Subject 85) specifically placed the patient at risk. Another (Subject 106) placed both the patient and nurse at risk. The remainder posed a threat to the nurse from potential exposure to blood and body fluids.

These incidents were evenly distributed between the two hospitals, three in ITU, five in surgical wards and two in medical wards. The ward where most were witnessed was ITU, Hospital B.

**Other observations**

Throughout data collection a number of incidents occurred repeatedly, worthy of comment, although not possible to quantify on the existing observation schedule. Touching the floor was considered a "dirty" manoeuvre and was frequently observed, particularly in ITU when nurses examined drainage bottles standing on the floor. Hands were not usually decontaminated after touching the floor.

On all wards nurses were frequently observed to touch their own faces and mucous membranes, apparently subconsciously, as hands were seldom decontaminated afterwards. Subject 118 (ITU, Hospital B) had a heavy cold and blew her nose four times without decontamination. She was the only subject who realised that contact with her own skin and mucous membranes was being recorded. Subject 167 (Ward 13) was observed scratching the perianal area, not followed by decontamination.

**Evidence of Idiosyncratic Behaviour**

Numerous authors conducting observation studies have commented on the stability and idiosyncrasies of the hand hygiene behaviour of individual nurses. Throughout the two hours they were watched, many nurses decontaminated too seldom for patterns to emerge, but there was limited evidence. For example, Subject 101 (ITU, Hospital B) not only decontaminated for an unusual length of time (mean 18 seconds when handwashing), she also turned away from the sink and talked at length to the patient while doing so, dripping water onto him and the bedclothes.

**The Effect of Experience on Observed Infection Control Practice**

One of the study aims was to document the effect of nurses' experience within their clinical specialty on observed infection control practice. Experience was introduced into ANOVA, against the effects of hospital and unit. Two significant findings emerged:-

Frequency of handwashing

$F(2, 169) = 8.51$ $\quad p < 0.004$

Less experienced nurses washed hands more often.

Less experienced nurses had higher scores on the Liberal Appropriateness Score:-

E $\quad F(2, 171) = 5.96$ $\quad p < 0.016$

Unit $\quad F(2, 171) = 4.14$ $\quad p < 0.018$

This effect was slightly more significant than that of the unit, also seen to be associated with Liberal Appropriateness Score (see page 314).

All other results were non-significant:-

Rigor Score

$F(2, 171) = 3.34$ $\quad p < 0.069$ $\quad$ N.S.

Frequency of handrub

$F(2, 78) = 0.53$ $\quad p < 0.470$ $\quad$ N.S.

Choice of Agent

$F(2, 171) = 0.67$ $\quad p < 0.413$ $\quad$ N.S.

Amalgamated Handwashing Score

~~F (2, 169) = 0.02 p <0.876 N.S.~~

Duration for handrub use

$F(2, 78) = 0.03$ $\quad p < 0.855$ $\quad$ N.S.

Number of hand surfaces decontaminated with handrub

$F(2, 78) = 0.76$ $p < 0.387$ N.S.

Number of occasions gloves were needed

$F(2, 113) = 2.53$ $p < 0.114$ N.S.

Number of occasions when gloves were worn

$F(2, 87) = 0.33$ $p < 0.568$ N.S.

Glovewearing score

$F(2, 113) = 0.12$ $p < 0.726$ N.S.

Inappropriate glove use

$F(2, 32) = 0.000$ $p < 0.995$

**Sociodemographic Variables and Observed Infection Control Practice**

The influence of other sociodemographic variables was examined by introducing them into ANOVA, against the effects of hospital and unit.

**Professional Nursing Qualifications (First or Second Level Nurses)**

No significant results were obtained.

Rigor Score

$F(2, 171) = 0.39$ $p < 0.533$ N.S.

Number of handwashes

$F(2, 169) = 0.12$ $p < 0.727$ N.S.

Liberal Appropriateness Score

$F(2, 171) = 0.20$ $p < 0.653$ N.S.

Amalgamated Handwashing Score

$F(2, 169) = 0.35$ $p < 0.557$ N.S.

Number of times handrub used

$F(2, 78) = 0.05$ $p < 0.822$ N.S.

Glovewearing score

F (2, 113) = 1.12 $p$ <0.328 N.S.

Inappropriate glove use

F (2, 32) = 0.04 $p$ <0.851 N.S.

Choice of Agent

F (2, 171) = 0.37 $p$ <0.543 N.S.

**Relevant Postbasic Certificate**

Holding a relevant postbasic nursing qualification did not influence clinical practice.

Rigor Score

F (2, 171) = 0.35 $p$ <0.555 N.S.

Number of handwashes

F (2, 169) = 0.33 $p$ <0.565 N.S.

Liberal Appropriateness Score

F (2, 171) = 1.68 $p$ <0.197 N.S.

Amalgamated Handwashing Score

F (2, 169) = 1.51 $p$ <0.221 N.S.

Number of times handrub used

F (2, 78) = 2.11 $p$ <0.148 N.S.

Glovewearing score

F (2, 113) = 0.53 $p$ <0.468 N.S.

Inappropriate glove use

F (2, 32) = 0.41 $p$ <0.523 N.S.

Choice of Agent

~~F (2, 171) = 0.01 p <0.914 N.S.~~

**Number of Years Qualified**

Nurses who had been qualified longer performed fewer handwashes, an effect independent of hospital or clinical setting:-

$F\ (2, 169) = 4.82 \quad p < 0.030$

Nurses who had been qualified longest also used handrub less often: an effect independent and less significant than that of hospital or unit:-

| | | |
|---|---|---|
| Years Qualified | $F\ (2, 78) = 3.83$ | $p < 0.053$ |
| Hospital | $F\ (2, 78) = 6.11$ | $p < 0.014$ |
| Unit | $F\ (2, 78) = 5.63$ | $p < 0.004$ |

All other results were non-significant:-

Rigor Score

$F\ (2, 171) = 0.00 \quad p < 0.986$ N.S.

Liberal Appropriateness Score

$F\ (2, 171) = 1.85 \quad p < 0.175$ N.S.

Choice of Agent

$F\ (2, 171) = 3.39 \quad p < 0.067$ N.S.

Duration of Handrub Use

$F\ (2, 78) = 0.000 \quad p < 0.963$ N.S.

Amalgamated Handwashing Score

$F\ (2, 169) = 1.35 \quad p < 0.247$ N.S.

Glovewearing score

$F\ (2, 113) = 0.20 \quad p < 0.659$ N.S.

Inappropriate glove use

$F\ (2, 32) = 2.40 \quad p < 0.123$ N.S.

As lack of experience and number of years qualified were associated with handwashing frequency, both were examined for possible interaction effects by entering them against hospital and unit data in ANOVA.

Experience alone was significant, suggesting that the earlier result could have occurred because experienced nurses tend to have been qualified longer:-

Number of years qualified:

$F\ (2, 169) = 1.52 \quad p < 0.219$ N.S.

Experience

$F\ (2, 169) = 10.04 \quad p < 0.002$

**Evaluation and Summary: Observation**

The observation schedule was designed for the study as Fulkerson's Scale for determining appropriateness of hand decontamination and Feldman's Criteria for judging quality of technique proved unsuitable.

No existing method had provision for documenting glove and sharps use and unlike the schedule eventually developed, no existing instrument allowed simultaneous documentation of frequency, appropriateness and technique. The method of estimating workload was inherent within the design of the instrument.

The versatility of the observation schedule was demonstrated in the ease with which it could be used in all three clinical settings.

It was possible to record nursing activities in detail so that appropriateness could be determined according to the strict criteria adopted by *Albert and Condie (1981)* as well as by a more liberal approach originating in the work of *Broughall et al (1984)* with additions from the literature judged according to the context in which they occurred. The tight criteria developed to evaluate quality of decontamination technique and appropriateness of glove and sharps use were satisfactory although it was occasionally necessary to make additions and elaborations. This was necessary on aesthetic grounds in relation to glove use and when unanticipated events occurred. Such was the richness and complexity of clinical behaviour that would probably have been necessary for as long as data collection continued.

## Range of Data Collection

As well as documentation of frequency, the schedule allowed technique of decontamination to be examined in detail. It was possible to develop an overall score, the Amalgamated Handwashing Score, which took into consideration duration, thoroughness, drying and disposal. Scores for each of these components correlated indicating that all were measuring aspects of the same construct. Sensitivity is discussed below. Choice of agent was apparently unrelated and not included. No score to evaluate technique of handrub use could be calculated, as the individual components failed to correlate but this may have been related to the speed of decontamination when alcohol was used, preventing accurate documentation, as discussed in a later section.

Although detailed data collection was possible with the schedule, particularly when handwashing rather than handrub use took place, some of the most striking findings were related to simple documentation of other phenomena, for example, the incidents of very poor practice and the tendency of subjects to persist in antisocial behaviour (e.g. touching mucous membranes, not followed by decontamination).

**The Sensitivity of the Amalgamated Handwashing Score**

Among the requirements of a measuring scale is that it should be sufficiently sensitive to discriminate between those individuals who genuinely perform well or poorly. The Amalgamated Handwashing Score reflected extremes of practice ranging from 4 to 12 (see Appendix 5), but this was dependent on the sensitivity of the individual components of which the overall score was composed. Its four components compared to the seven incorporated into Feldman's Criteria suggest that it may have been less sensitive, particularly as it was less easy to identify the stability of individual behaviour this reported by authors who have adopted Feldman's Criteria (see *Larson, McGinley and Grove, 1986*). Additionally, the range of different scores that it was possible to award with some of the components of the Amalgamated Handwashing Score was restricted. Each of these is discussed in turn.

Duration was originally recorded in seconds. Correlation to other potential components of the score proceeded with raw data so that no ~~information would be lost. When correlation was established it was~~ necessary to categorise duration into three scores so that the overall Amalgamated Score could be formed (see Appendix 6).

This resulted in some loss of information, although minimal, as the maximum score was 12 and very few subjects had decontaminated for more than 12 seconds.

Thoroughness was judged according to the number of hand surfaces decontaminated. It was possible to award three different scores.

Drying was judged according to three possible scores, but as every individual made some attempt to dry hands, in practice only two scores were employed.

Disposal was judged according to two possible scores: 0 or 12. However, this could not be made more sensitive as only two possibilities existed: correct or incorrect disposal.

Reference to Table 5.2 demonstrates that for two of the seven components of Feldman's criteria a range of two possible scores exist, while for the remaining five components, three possibilities exist. It may therefore be concluded that the Amalgamated Handwashing Score is somewhat less sensitive, but as this contributes towards its utility in fieldwork and it appears valid, it was taken to represent a suitable means of assessing handwashing practice.

**Limitations inherent within the method of observation**

These relate to under-representation of some events, failure to document detail and the Hawthorn Effect.

**Under-representation of events**

Although the study involved a relatively large sample, some types of data were under-represented because they were performed too seldom. Some nurses did not wear gloves or handle sharps, so some statistical analysis, for example in relation to inappropriate glove use, was impossible.

**Failure to Document Detail**

Two hours observation proved optimal. After this time fatigue was a problem and the researcher would not have wished to presume further on subjects' goodwill, but this comparatively short period was generally sufficient for enough clinical contacts to be made to permit meaningful analysis. Shadowing nurses permitted continual data collection: to have observed subjects simultaneously as described by *Albert and Condie (1981)* and *Linden (1990)* would not have been possible.

Inevitably when observation was performed so closely, some details were lost. The number of hand surfaces decontaminated or duration might be omitted, particularly when episodes of decontamination were over quickly, although seldom more than once for the same nurse. As a result, duration and surface scores may have been inflated.

This was particularly likely when handrub was used, as its duration was generally brief.

*Ojajarvi (1991)* noted reduced duration when handrub was employed, owing to its lack of viscosity, which permits it to "slip through the fingers". Emollients can enhance effectiveness by delaying drying (*Larson, Eke and Wilder, 1987*), but events may still occur too swiftly for accurate decontamination when handrub is used. There was some evidence in this study that nurses, particularly in ITU Hospital B, employed handrub when they were too busy to wash hands in the conventional way, so the brief duration of many episodes, including those not timed, is understandable.

The Hawthorn Effect could also influence generalisability, as individuals may have reacted differently when watched. Discussion in relation to obtaining the sample also revealed that on some wards the inclusion of particularly senior or junior nurses was promoted. As recruitment to the observational element of the study provided the key to the collection of the remainder of the data, this could also have been biased the results of the questionnaires and interviews.

**Aim 5 To examine the influence of workload and dependency on nurses' infection control practice**

Two methods of assessing levels of clinical activity were employed, as explained in Chapter Five: workload and dependency. As in Aim 4, bivariate analysis was performed on the data yielded by preliminary analysis, then ANOVA was performed where appropriate.

**Workload (Total Number of Clinical Contacts)**

Results presented under Aim 4 show that number of clinical contacts was significantly greater in ITU, Hospital A.

**The Effect of Workload on Observed Clinical Practice**

**Hand Decontamination**

Rigor Score Frequency

$r_s$ <0 0.490 $p$ = <0.005 $n$ = 171

For the overall sample, frequency of hand decontamination increased with workload. The effect on the six units and two hospitals was further examined with ANOVA:-

Workload

| | | | |
|---|---|---|---|
| Hospital | $F(1, 173) = 2.18$ | $p = 0.142$ | N.S. |
| Unit | $F(2, 173) = 8.37$ | $p = 0.000$ | |

Rigor Score

| | | | |
|---|---|---|---|
| Hospital | $F(1, 171) = 0.113$ | $p < 0.222$ | N.S. |
| Unit | $F(2, 171) = 0.088$ | $p < 0.837$ | N.S. |

Workload, but not Rigor Score was significantly associated with unit.

Liberal Appropriateness Score

$r_s = 0.843$ $p < 0.005$ $n = 171$

As workload increased, the number of essential hand decontaminations for the sample overall showed significant increase. However, results from the ANOVA indicate that this was associated with particular units:-

| | | | |
|---|---|---|---|
| Hospital | $F(1, 171) = 1.37$ | $p = 0.243$ | N.S. |
| Unit | $F(2, 171) = 3.86$ | $p = 0.02$ | |

Total number of decontaminations $r_s = 0.387$ $p < 0.005$ $n = 169$

As workload increased, so did total number of decontaminations. ~~However, this result is not confirmed by ANOVA.~~

| | | |
|---|---|---|
| Hospital | $F(1, 169) = 0.10$ | $p < 0.756$ |
| Unit | $F(2, 169) = 0.16$ | $p < 0.850$ |

Handrub use $r_s = 0.366$ $p < 0.005$ $n = 78$

As workload increased, episodes of handrub use increased significantly for the sample overall. This result is confirmed by ANOVA, but the unit effect is most highly significant:-

| | | |
|---|---|---|
| Hospital | $F (1, 78) = 6.12$ | $p < 0.014$ |
| Unit | $F (2, 78) = 7.66$ | $p < 0.001$ |

Amalgamated Handwashing Score

$r_s = 0.135$ N.S. $n = 169$

As number of clinical contacts increased, performance of handwashing technique remained unaltered for the sample as a whole.

This result is confirmed by ANOVA:-

| | | | |
|---|---|---|---|
| Workload | $F (2, 169) = 0.23$ | $p < 0.630$ | N.S. |
| Hospital | $F (2, 169) = 1.87$ | $p < 0.173$ | N.S. |
| Unit | $F (2, 169) = 15.95$ | $p < 0.0000$ | |

Only the unit influenced handwashing performance. From Aim 4, it is known that this is superior on ITU, Hospital B.

**Glove Use**

Number of times gloves were required

$r_s = 0.440$ $p < 0.005$ $n = 113$

As workload for the sample overall increased, gloves were required more often. This result was confirmed by ANOVA:-

| | | |
|---|---|---|
| Hospital | $F (1, 113) = 5.67$ | $p < 0.018$ |
| Unit | $F (2, 113) = 14.70$ | $p < 0.0000$ |

Number of times gloves worn

$r_s = 0.312 \quad p < 0.005 \quad n = 87$

For the sample overall, as clinical contacts increased, gloves were used more. ANOVA confirmed that this effect was associated with unit. Gloves were worn most often on ITU (see Aim 4):-

| | | | |
|---|---|---|---|
| Hospital | $F(1, 87) = 0.07$ | $p < 0.791$ | N.S. |
| Unit | $F(2, 87) = 31.02$ | $p < 0.0000$ | |

Glovewearing score

$r_s = -0.122$ N.S. $n = 113$

Increasing workload did not influence glovewearing score. ANOVA partly confirms this result:-

| | | | |
|---|---|---|---|
| Workload | $F(2, 113) = 0.71$ | $p < 0.400$ | N.S. |
| Hospital | $F(1, 113) = 5.47$ | $p < 0.021$ | |
| Unit | $F(2, 113) = 1.13$ | $p < 0.327$ | |

As indicated in Aim 4, glovewearing score was significantly greater in Hospital A.

**Sharps Use**

Frequency of sharps use

$r_s = 0.260 \quad p = < 0.005 \quad n = 144$

As workload increased, sharps were used significantly more often by the sample overall. ANOVA suggested that this effect was influenced by unit:-

| | | | |
|---|---|---|---|
| Hospital | $F(1, 144) = 1.02$ | $p < 0.315$ | N.S. |
| Unit | $F(2, 144) = 3.22$ | $p < 0.043$ | |

The number of nurses who handled and disposed of sharps dangerously was too small to submit to statistical analysis. Inspection of the raw data did not suggest that this might be related to workload.

**Relationship between sociodemographic data and workload**

Traditionally nursing tasks have been regarded as skilled and unskilled, with those unqualified or training performing most of the latter (*Goddard, 1953*), although this classification has been disputed (*Smith, 1987*). However, the possibility that some procedures might be performed by nurses with particular experience or qualifications could not be overlooked, so workload was examined in relation to sociodemographic variables. Only one result was significant: nurses with a relevant postbasic certificate performed more clinical contacts:-

| | | | |
|---|---|---|---|
| Experience | W = 6462 | $p$ <0.1962 | N.S. |
| Professional Qualifications | W = 13421 | $p$ <0.7022 | N.S. |
| Number of years qualified | H = 0.71 | 2*df* $p$ <0.7000 | N.S. |
| ENB Certificate | W = 7120 | p <0.0262 | |

Many of the nurses holding postbasic certificates were employed in ITU, so a Model was constructed to examine the relationship between these effects:-

| | | | |
|---|---|---|---|
| Hospital | F (1, 173) = 2.52 | $p$ <0.114 | N.S. |
| Unit | F (2, 173) = 5.05 | $p$ <0.007 | |
| ENB Certificate | F (2, 173) = 0.32 | $p$ <0.570 | |

Postbasic qualification no longer appeared significant.

## Dependency

The Dependency Scale developed from an existing instrument by *Barr (1964)* provided a measure of ward activity, created by the demands of all the patients, distributed among all nurses. Data were available for one hundred and seventy-one of the nurses observed.

The validity of using a Dependency Measure in this manner was unknown and could be questioned, as it takes into consideration non-clinical activities, including administration.

## Results of the Dependency Measure

Dependency Score overall was 46.78.

**Table 6.57 Results of the Dependency Measure**

| | A | B | Both Hospitals |
|---|---|---|---|
| ITU | 31 | 36.17 | 33.58 |
| Surgical | 41 | 63.77 | 52.42 |
| Medical | 54 | 57.23 | 55.67 $n = 171$ |
| All | 41.33 | 52.16 | 46.78 SD = 17.1 |

Dependency was significantly greater in Hospital B (see Table 6.57).

W = 6000 $p < 0.0001$

Dependency was significantly much lower in ITU:-

~~H = 55.65 *2df* *p* <0.000~~

This conflicts with data from the workload measure, which indicated ITU, Hospital A as demonstrating greater activity in purely clinical terms. When ANOVA was performed, hospital and unit effects were both highly significant:-

| | | |
|---|---|---|
| Hospital | $F(1, 171) = 28.94$ | $p < 0.000$ |
| Unit | $F(2, 171) = 47.88$ | $p < 0.000$ |

**The Effect of Dependency on Observed Clinical Practice**

**Hand Decontamination**

Rigor Score

$r_s = -0.054$ N.S. $n = 171$

Liberal Appropriateness Score

$r_s = -0.072$ N.S. $n = 171$

Number of handwashes

$r_s = 0.015$ N.S. $n = 169$

Number of times handrub was used

$r_s = -0.113$ N.S. $n = 169$

Amalgamated Handwashing Score

$r_s = -0.239$ $p < 0.01$ $n = 169$

One significant result was obtained: as dependency increased, handwashing technique deteriorated. ANOVA indicated that the unit effect was significant:-

| | | | |
|---|---|---|---|
| Hospital | $F(1, 169) = 0.02$ | $p < 0.876$ | N.S. |
| Unit | $F(2, 169) = 5.47$ | $p < 0.005$ | |

This does not concord with results from the workload measure.

**Glove Use**

Opportunity to wear gloves

$r_s$ = - 0.131 N.S. $n$ = 113

Number of times gloves were worn

$r_s$ = - 0.242 $p$ <0.00 $n$ = 87

Glovewearing score

$r_s$ = 0.005 N.S. $n$ = 113

One significant result was obtained. As dependency increased, gloves were worn less often. This relationship was further investigated with ANOVA:-

| | | | |
|---|---|---|---|
| Hospital | F (1, 113) = 0.14 | $p$ <0.704 | N.S. |
| Unit | F (2, 113) = 7.04 | $p$ <0.001 | |

The unit effect was significant.

**Sharps Use**

Number of times sharps were used

$r_s$ = 0.138 N.S. $n$ = 144

This result was not significant.

As before, number of times that sharps were incorrectly handled or discarded was too small for statistical manipulation, but from the raw data there was nothing to suggest behaviour might be related to dependency.

**The Effect of Sociodemographic Variables on Dependency**

Dependency would not logically alter with variables related to the nurse observed. Details for the entire ward were generally provided by the nurse in charge and might be influenced by her outlook, but to assess this lay beyond the scope of the study.

**Relationship between Workload and Dependency**

Spearman's Rank Correlation Coefficient revealed no significant association between these two variables:-

$r_s = -0.082$ N.S. $n < 171$

This could be owing to a tendency for more nurses to be sent to a ward when it was busy.

**The influence of time of day on observed clinical practice**

During pilot work it was apparent that some nursing activities were associated with particular times of day: on general wards but to a much lesser extent in ITU, patients received help with personal hygiene early in the morning. Time of each episode of observation was therefore recorded according to the following scheme:-

| | |
|---|---|
| Early morning | 8 - 10 am |
| Late morning | 10 am onwards |
| Afternoon | 1.30 pm onwards |

Time was recorded from commencement of observation.

**TABLE 6.59 Time of Observation**

| | | A | | B | | Both Hospitals | |
|---|---|---|---|---|---|---|---|
| | | N° | % | N° | % | N° | % |
| ITU | early morning | 9 | 30 | 7 | 23.33 | 16 | 26.68 |
| | late morning | 12 | 60 | 13 | 43.34 | 25 | 41.66 |
| | afternoon | 9 | 30 | 10 | 33.33 | 19 | 31.66 |
| Surgical | early morning | 8 | 26.66 | 3 | 10 | 11 | 18.33 |
| | late morning | 17 | 56.68 | 17 | 56.68 | 34 | 56.66 |
| | afternoon | 5 | 16.66 | 10 | 33.32 | 15 | 25.01 |
| Medical | early morning | 4 | 14.81 | 6 | 23.08 | 10 | 18.86 |
| | late morning | 17 | 62.97 | 10 | 38.46 | 27 | 50.94 |
| | afternoon | 6 | 22.22 | 10 | 38.46 | 16 | 30.2 |
| | | 87 | | 86 | | 87 | |

Most observations took place in the early morning (see Table 6.58), although spread more evenly over the working day in ITU than for the wards. This was a consequence of conducting fieldwork in a busy clinical environment when the time at which the researchers were welcome was variable and a matter for negotiation with the nurse in charge. The nature of work on ITU and the ability of the researcher to remain in one location, sometimes for the whole period of observation, meant that staff were spared disruption by early visits and did not object to them. Early visits were actively discouraged on some general wards, especially Ward 12, where observation was felt to interfere with the consultant's round.

Although time of observation was considered beyond the researcher's control, its possible effect on the results was examined. According to the results of Kruskal Wallis tests, there were two significant findings:-

Workload

H = 8.60 3*df* $p$ <0.036

Liberal Appropriateness Score

H = 9.84 3*df* $p$ <0.020

During early morning workload was highest, with a higher number of essential hand decontaminations performed.

On ITU, total patient care was always practised, with one nurse never responsible for more than one or two patients, while on general wards one nurse was always responsible for the care of a number of patients, so ITU and general wards were examined separately for the effects of time of day on workload. It became apparent that time of day had no significant effect on ITU, but on general wards workload was highest in the early morning and lowest in the afternoon:-

ITU H = 0.76 2*df* $p$ <0.682 N.S.

General wards H = 9 3*df* $p$ <0.030

All other findings were non-significant:-

Dependency

H = 2.72 3*df* $p$ <0.437 N.S.

Rigor Score

H = 2.03 3*df* $p$ <0.567 N.S.

Amalgamated Handwashing Score

H = 2.31 $p$ <0.511 N.S.

Need to wear gloves

H = 1.94 3*df* $p$ <0.589 N.S.

Glovewearing score

H = 0.25 3*df* $p$ <0.884 N.S.

Number of times sharps were used

$H = 0.28$   $3df$   $p < 0.963$   N.S.

**The Influence of Weekday on Observed Clinical Practice**

Some events on wards are determined by day of the week, for example consultants' rounds and operating sessions. As these have potential to affect nursing activity, day of the week could have affected observation data. This was not possible to document systematically because too few episodes of observation took place on individual wards to allow patterns to emerge. When field notes were examined it appeared, however, that the researchers were likely to be warned against data collection on these atypical days: access was not granted on the morning of consultants' rounds on Wards 12 and on operating day on Ward 3, possibly reducing the effect of atypical working patterns on these "special" days. Examination of the raw data suggested that day of the week was evenly represented throughout data collection for the sample considered as a whole.

**Evaluation and Summary: Levels of Ward Activity**

Workload (total number of clinical contacts) was regarded as a valid indicator of level of nursing activity for any subject, because it reflected the number of nursing interventions performed and therefore opportunities for cross-infection. This was a modification of the approach taken by *Doebbeling et al (1992)*. It excluded administration, which does not carry risks of cross-infection.

Dependency, a measure of all the nursing activity on the ward including administration, shared among all the nurses, was also recorded as it was thought to be a reasonable indicator of nursing activity on general wards, where nurses cared for a group of patients and often supervised the work of juniors. The Dependency Scale, developed from a measure by *Barr (1964)* fulfilled the required criteria of simplicity and straightforwardness necessary for this study, but its validity is cast into doubt as the results failed to correlate with those of workload: wards where most clinical contacts were initiated were not those with the highest dependency scores. The tendency for ITU to have lowest dependency appears to be a fault of the scale relating to sensitivity and the degree to which it was appropriate for use with critically ill patients. The maximum score for heavily dependent patients was five, so this was given to all ITU patients. The maximum score for the entire unit would thus always be low compared to that of a ward because ITU always had fewer beds. There was some evidence that bias resulted through different interpretation on the part of staff, affecting reliability. For example in Ward 5 a patient scored maximally because she was confused and liable to wander off the ward. This score was as high as that available for a ventilated patient in ITU, with a catheter and multiple intravenous lines. On the following day the same patient on Ward 5 was given a score of 3 by a different nurse. *Giovannetti (1984)* claims that problems of reliability can be overcome by staff training programmes, but this lay beyond the scope of the study.

*Barr's* work was undertaken nearly thirty years ago, when technology, today in routine use, had not been envisaged and is therefore not taken into consideration.

It is too simple for use in ITU. More appropriate and refined scoring systems especially for use with the critically ill have since been developed (*Large, Nattrass and Simpson, 1991*).

Overall, workload appeared the most effective measure of assessing levels of ward activity. It was highest in ITU Hospital A, but was not associated with a marked increase in hand decontamination frequency although as nurses became busier in ITU Hospital B they performed more essential decontaminations. Performance of technique was not influenced by workload.

As the units became busier both the need and actual use of gloves and sharps increased, particularly in ITU, but there was no effect on the type of gloves worn.

The time of day when observation took place influenced workload on wards but not ITU, while the influence of weekday on the results of workload did not seriously affect the type of data collected.

**Aim 6 To determine how knowledge and opinions of infection control are translated into clinical nursing practice**

Aim 6 is presented as three sections.

In the first section the association of knowledge with clinical practice is examined by performing ANOVA on the observation data, introducing scores from each of the knowledge questionnaires against ~~the effects of hospital and clinical setting. The relationship between~~ individual questions and clinical practice is explored with bivariate analysis.

In the second section the association between Likert ratings and interview responses on clinical practice is explored.

In a third section the relationship between interview data and knowledge on observation data is considered.

Finally the interactive effects of hospital, clinical setting, knowledge and workload on clinical practice are explored.

**The Relationship between Knowledge and Clinical Practice**

**Case Study 1: Blood and Body Fluids Precautions**

Rigor Score/Frequency

F(2, 127) = 0.000 *p* <0.983 N.S.

Liberal Appropriateness Score

F (2, 130) = 0.38 *p* <0.538 N.S.

Amalgamated Handwashing Score (technique)

F (2, 125) = 0.18 *p* <0.670 N.S.

Glovewearing Score

F (2, 113) = 0.000 <0.979 N.S.

Knowledge of blood and body fluids precautions was not associated with the results of observed clinical practice.

**Case Study 2: Contact Precautions**

Rigor Score

F (2, 128) = 0.82 *p* <0.368 N.S.

Liberal Appropriateness Score

Unit

F (2, 130) = 3.25 *p* <0.042

Case Study 2

$F(2, 130) = 4.22$ $p < 0.042$

Unit/Case Study 2

$F(2, 130) = 2.49$ $p < 0.087$ N.S.

This result confirmed Aim 4: clinical setting was associated with Liberal Appropriateness Score. However, knowledge of contact precautions was independently associated with superior Liberal Appropriateness Score rating.

Amalgamated Handwashing Score

$F(2, 125) = 2.53$ $p < 0.114$ N.S.

Glovewearing Score

$F(2, 113) = 0.03$ $p < 0.862$ N.S.

Glovewearing score was not associated with knowledge of contact precautions. However, the validity of this interpretation is questionable, as during observation nurses wore gloves chiefly to protect themselves from blood and body fluids rather than to reduce bacterial dissemination.

**Principles of Microbiology**

Rigor Score

$F(2, 128) = 0.02$ $p < 0.884$ N.S.

Liberal Appropriateness Score

$F(2, 129) = 0.28$ $p < 0.597$ N.S.

Amalgamated Handwashing Score

Unit

$F(2, 125) = 2.97$ $p < 0.056$

Principles

$F(2, 125) = 4.41$ $p < 0.038$

Unit/Principles

F (2, 125) = 1.04 $p < 0.0357$

This result confirms Aim 4: clinical setting (ITU) is significantly associated with higher performance, but knowledge of the principles underpinning infection control plays a more significant role, although both factors interact in their relationship with handwashing performance.

Glovewearing Score

F (2, 113) = 0.09 $p < 0.766$ N.S.

**Knowledge of Hand Hygiene for Specific Nursing Procedures**

Rigor Score

F (2, 128) = 0.57 $p < 0.451$ N.S.

Liberal Appropriateness Score

F (2, 128) = 0.01 $p < 0.918$ N.S.

Amalgamated Handwashing Score

F (2, 125) = 1.40 $p < 0.238$ N.S.

Glovewearing Score

F (2, 113) = 0.62 $p < 0.435$ N.S.

No significant results were obtained.

**Relationship between knowledge revealed by specific questions on the knowledge questionnaires and observed clinical practice**

As each question was intended to elicit information about related but different aspects of infection prevention, their relationships with appropriate aspects of observed clinical practice were examined separately.

**Case Study 1 Blood and Body Fluids Precautions**

*Qr1 Blood and body fluid precautions*

The following non-significant results were obtained:-

Amalgamated Handwashing Score

H = 1.63 4*df* $p < 0.803$ N.S.

Rigor Score

H = 1.84 4*df* $p < 0.766$ N.S.

Liberal Appropriateness Score

H = 4.33 4*df* $p < 0.363$ N.S.

Glovewearing Score

H = 4.03 4*df* $p < 0.402$ N.S.

Although hand decontamination and glove use are recommended to reduce risks of parenteral virus infection, this knowledge was not associated with differences in clinical practice between nurses.

*Qr26 Need for universal blood and body fluid precautions for all patients*

Amalgamated Handwashing Score

W = 2961.5 $p < 0.2073$ N.S.

Rigor Score

W = 3430.5 $p < 0.9089$ N.S.

Liberal Appropriateness Score

W = 3281.5 $p < 0.555$ N.S.

Glovewearing Score

W = 1473 $p < 0.1263$ N.S.

Universal precautions are recommended for all patients regardless of whether their antibody status is known, but correct responses were not associated with differences in clinical practice.

*Qr3 HIV precautions*

Glovewearing score

W = 124 $p$ <0.7865 N.S.

The same precautions are required against HIV and HBV, but correctly answering this question had no effect on behaviour, a result which is not surprising, as most nurses answered this question correctly (see Aim 3).

***Qr6 Risk of urinary tract infection for a patient with a long term indwelling Foley catheter (more than three days)***

Amalgamated Handwashing Score

W = 3630 $p$ <0.9093 N.S.

Rigor Score

W = 4464.5 $p$ <0.0003 N.S.

Liberal Appropriateness Score

W = 3900.5 $p$ <0.6593 N.S.

Glovewearing Score

W = 1933 $p$ <0.7150 N.S.

Risks of urinary tract infection in this situation are considerable. Hand decontamination and glove use help reduce contact spread. Unexpectedly, nurses who under-estimated the risk of infection washed hands more often (Rigor Score).

**Case Study 2 Contact precautions**

***Qr8 Why is MRSA considered such a problem in hospitals?***

Rigor Score

H = 0.21 *2df* $p$ <0.900 N.S.

Liberal Appropriateness Score

H = 0.21 *2df* $p$ <0.900 N.S.

Glovewearing Score

$H = 0.99$  $2df$  $p < 0.609$  N.S.

Amalgamated Handwashing Score

$H = 6.41$  $2df$  $p < 0.041$

Nurses whose knowledge was satisfactory had more expert handwashing technique

***Qr9 How is MRSA spread?***

Amalgamated Handwashing Score

$W = 3292.5$  $p < 0.0738$  N.S.

Rigor Score

$W = 4179.5$  $p < 0.1399$  N.S.

Liberal Appropriateness Score

$W = 3955$  $p < 0.0677$  N.S.

Glovewearing Score

$W = 2025$  $p < 0.7154$  N.S.

Nurses with satisfactory knowledge had similar clinical behaviour to those whose knowledge was poor.

***Qr10a The need to wear gloves when attending a patient with MRSA***

Amalgamated Handwashing Score

$W = 1434.5$  $p < 0.9289$  N.S.

Rigor Score

$W = 1620.5$  $p < 0.9291$  N.S.

LAS

$W = 1335$  $p < 0.0739$  N.S.

Glovewearing Score

W = 691 $p < 0.9956$ N.S.

No significant results were obtained.

*Qr10b* *Need to wash hands when attending a patient with MRSA*

Amalgamated Handwashing Score

W = 463 $p < 0.8174$ N.S.

Rigor Score

W = 479 $p < 0.6652$ N.S.

Liberal Appropriateness Score

W = 323.5 $p < 0.0523$ N.S.

Glovewearing Score

W = 325.5 $p < 0.0876$ N.S.

Nurses with satisfactory knowledge performed essential hand decontaminations.

**Principles of Microbiology**

This questionnaire considered as a whole produced a number of significant findings, but questions could not be considered individually because it was not possible to relate individual questions concerned with theory to observed practice.

**Relationship between Opinions and Clinical Practice**

The relationship between nurses' opinions of infection control elicited with the Likert scale in conjunction with observed clinical practice was examined by bivariate statistical analysis to yield non-significant findings.

The results were confirmed when the Likert ratings were introduced against the effects of hospital and clinical setting in ANOVA. The effect of Likert scores alone could not be examined by ANOVA in Aim 2, because ordinal data cannot be used in this test except when introduced alongside interval level data.

Amalgamated Handwashing Score

$H = 2.19$    $3df$    $p < 0.534$    N.S.

$F(2, 125) = 0.64$    $p < 0.425$    N.S.

Rigor Score

$H = 2.54$    $3df$    $p < 0.468$    N.S.

$F(2, 139) = 0.38$    $p < 0.698$    N.S.

Liberal Appropriateness Score

$H = 5.64$    $3df$    $p < 0.131$    N.S.

$F(2, 139) = 0.28$    $p < 0.597$    N.S.

Glovewearing Score

$H = 2.64$    $3df$    $p < 0.424$    N.S.

$F(2, 113) = 0.09$    $p < 0.766$    N.S.

**Summary: The relationship between knowledge, opinions of infection control and clinical nursing practice**

Nurses with higher scores for contact precautions performed more essential decontaminations. There was an interactive effect between technique of decontamination, clinical setting and knowledge of the theoretical principles underlying infection control, ITU nurses faring most favourably. Very few individual questions were linked with observed practice, although nurses who were aware that hands should be washed after attending a patient with MRSA performed more essential decontaminations. Likert scores were not associated with observed clinical practice.

**The Relationship between Interview Data and Knowledge and Observation**

From Aim 2 it was apparent that nurses in Hospital A were more likely to consider their patients to be at risk of infection (Q2a) so a model was constructed to explore the relationship between interview response, hospital and total score for Case Study 2 (contact precautions). Results were not significant:-

| | | | |
|---|---|---|---|
| Q2a | $F(1, 130) = 0.02$ | $p < 0.0895$ | N.S. |
| Q2a/Hospital | $F(2, 130) = 0.66$ | $p < 0.117$ | N.S. |

However, believing patients to be at risk of infection was associated with a modest increase in total number and essential decontaminations but not with technique:-

Total number of decontaminations (Rigor Score)

| | | | |
|---|---|---|---|
| Q2a | $F(1, 171)= 3.83$ | $p < 0.05$ | |
| Q2a/Hospital | $F(1, 171)= 1.410$ | $p < 0.236$ | N.S. |

Liberal Appropriateness Score

| | | | |
|---|---|---|---|
| Q2a | $F(1, 171)= 4.20$ | $p < 0.04$ | |
| Q2a/Hospital | $F(2, 171)= 1.24$ | $p < 0.268$ | N.S. |

Amalgamated Handwashing Score

| | | | |
|---|---|---|---|
| Q2a | $F(1, 171)= 1.31$ | $p < 0.36$ | N.S. |
| Q2a/Hospital | $F(2, 171)= 1.46$ | $p < 0.246$ | N.S. |

ITU nurses were more likely to consider their patients to be at risk. This relationship was explored in conjunction with knowledge and practice.

Case Study 2 (Contact Precautions)

| | | |
|---|---|---|
| Q2a | $F(1, 130) = 0.01$ | $p < 0.911$ |
| Q2a/ITU | $F(2, 130) = 1.03$ | $p < 0.359$ N.S. |

Total number of decontaminations (Rigor Score)

| | | |
|---|---|---|
| Q2a | $F(1, 171) = 1.34$ | $p < 0.249$ |
| Q2a/ITU | $F(2, 171) = 0.35$ | $p < 0.706$ |

Liberal Appropriateness Score

| | | |
|---|---|---|
| Q2a | $F(1, 171) = 1.33$ | $p < 0.250$ N.S. |
| Q2a/ITU | $F(2, 171) = 2.26$ | $p < 0.108$ N.S. |

Amalgamated Handwashing Score

| | | |
|---|---|---|
| Q2a | $F(1, 171) = 1.34$ | $p < 0.249$ N.S. |
| Q2a/Hospital | $F(2, 171) = 0.35$ | $p < 0.706$ N.S. |

ITU nurses were more likely to consider themselves at risk (Q3a) so a model was constructed to examine the relationship of interview response to knowledge and practice. There was one significant finding: an interactive effect emerged between work in ITU and belief that self was at risk on knowledge of blood and body fluid precautions.

Case Study 1 (blood/body precautions)

| | | |
|---|---|---|
| Q3a | $F(1, 130) = 0.01$ | $p < 0.932$ N.S. |
| Q3a/ITU | $F(2, 130) = 4.08$ | $p < 0.019$ N.S. |

Principles of Microbiology

| | | |
|---|---|---|
| Q3a | $F(1, 129) = 1.07$ | $p < 0.303$ N.S. |
| Q3a/ITU | $F(2, 129) = 0.06$ | $p < 0.938$ N.S. |

~~Total number of decontaminations (Rigor Score)~~

| | | |
|---|---|---|
| Q3a | $F(1, 171) = 0.80$ | $p < 0.373$ N.S. |
| Q3a/ITU | $F(2, 171) = 0.45$ | $p < 0\ 636$ N.S. |

Liberal Appropriateness Score

| | | |
|---|---|---|
| Q3a | $F(1, 171) = 1.45$ | $p < 0.231$ N.S. |
| Q3a/ITU | $F(2, 171) = 0.11$ | $p < 0.894$ N.S. |

Amalgamated Handwashing Score

| | | |
|---|---|---|
| Q3a | $F(1, 171) = 1.49$ | $p < 0.244$ N.S. |
| Q3a/Hospital | $F(2, 171) = 0.22$ | $p < 0.733$ N.S. |

ITU nurses recalled post-basic input more often than others so the effect of this response on knowledge and behaviour was examined.

Case Study 1 (blood/body precautions)

| | | |
|---|---|---|
| Q8a | $F(1, 130) = 3.32$ | $p < 0.071$ N.S. |
| Q8a/ITU | $F(2, 130) = 0.33$ | $p < 0.721$ N.S. |

Case Study 2 (contact precautions)

| | | |
|---|---|---|
| Q8a | $F(1, 130) = 0.02$ | $p < 0.881$ N.S. |
| Q8a/ITU | $F(2, 130) = 0.33$ | $p < 0.163$ N.S. |

Principles of Microbiology

| | | |
|---|---|---|
| Q8a | $F(1, 129) = 0.000$ | $p < 0.971$ N.S. |
| Q8a/ITU | $F(2, 129) = 1.30$ | $p < 0.276$ N.S. |

Total number of decontaminations

| | | |
|---|---|---|
| Q8a | $F(1, 171) = 0.03$ | $p < 0.867$ N.S. |
| Q8a/ITU | $F(2, 171) = 0.03$ | $p < 0.974$ N.S. |

Liberal Appropriateness Score

| | | |
|---|---|---|
| Q8a | $F(1, 171) = 0.578$ | N.S. |
| Q8a/ITU | $F(2, 171) = 0.2$ | $p < 0.823$ N.S. |

Nurses in Hospital A were more likely to have seen their policy (Q12) but there was no relationship between this and knowledge or practice

Case Study 1 (blood/body fluids)

Q12 $F(1, 130) = 0.000$ $p < 0.987$ N.S.

Q12/Hospital $F(1, 130) = 1.83$ $p < 0.178$ N.S.

Case Study 2 (contact precautions)

Q12 $F(1, 130) = 1.31$ $p < 9.254$ N.S.

Q12/Hospital $F(2, 130) = 0.52$ $p < 0.473$ N.S.

Principles of Microbiology

Q12 $F(1, 129) = 2.56$ $p < 0.112$ N.S.

Q12/Hospital $F(2, 129) = 3.27$ $p < 0.73$

Total number of decontaminations

Q12 $F(1, 171) = 3.56$ $p < 0.061$ N.S.

Q12/Hospital $F(1, 171) = 1.00$ $p < 0.319$ N.S.

Liberal Appropriateness Score

Q12 1*df* $F(1, 171) = 0.05$ $p < 0.832$ N.S.

Q12/Hospital $F(2, 171) = 0.04$ $p < 0.845$ N.S.

Amalgamated Handwashing Score

Q12 1*df* $F(1, 171) = 2.44$ $p < 0.122$ N.S.

Q12/Hospital $F(2, 171) = 3.22$ $p < 0.75$ N.S.

**Summary**

Nurses who believed their patients to be at greatest risk performed decontaminations more often, while the nurses who be believed themselves to be at risk of infection had superior knowledge ~~of blood and body fluid precautions.~~

**The interactive effects of hospital, unit, knowledge of contact precautions and workload on clinical practice**

In view of their significant effects on aspects of observed clinical practice the above variables were explored for their combined effects on behaviour:-

Amalgamated Handwashing Score

| | | | |
|---|---|---|---|
| Hospital | $F(1, 169) = 0.41$ | $p < 0.525$ | N.S. |
| Unit | $F(2, 169) = 4.55$ | $p < 0.014$ | |
| Contact Precautions | $F(2, 169) = 1.32$ | $p < 0.155$ | N.S. |
| Workload | $F(2, 169) = 0.90$ | $p < 0.576$ | N.S. |

The unit effect on handwashing performance was significant. Performance was superior on ITU.

Liberal Appropriateness Score

| | | | |
|---|---|---|---|
| Hospital | $F(1, 130) = 1.15$ | $p < 0.288$ | N.S. |
| Unit | $F(2, 130) = 0.91$ | $p < 0.408$ | N.s. |
| Contact Precautions | $F(2, 130) = 4.67$ | $p < 0.000$ | |
| Workload | $F(2, 130) = 0.62$ | $p < 0.865$ | N.S. |

Knowledge of contact precautions was significantly associated with frequency of essential hand decontaminations.

Glovewearing Score

| | | | |
|---|---|---|---|
| Hospital | $F(1, 99) = 1.33$ | $p < 0.257$ | N.S. |
| Unit | $F(2, 99) = 0.96$ | $p < 0.391$ | N.S. |
| Contact Precautions | $F(2, 99) = 0.69$ | $p < 0.863$ | N.S. |
| Workload | $F(2, 99) = 0.84$ | $p < 0.635$ | N.S. |

No significant results were obtained.

It was not possible to examine the effects of knowledge of the Principles of Microbiology on clinical behaviour because there was too much missing data. For the same reason it was not possible to examine a model investigating relationships between clinical setting, observed behaviour and whether or not nurses believed themselves or their patients to be at particular risk of infection.

**Evaluation: the multi-method approach**

The overall aim of the study was to determine how nurses performed key infection control measures and the influence of knowledge, opinions and facilities on behaviour. This was necessary because data obtained solely by interview or questionnaire provide information only of what subjects claim they will do in a hypothetical situation, not how they may actually behave (*Gould, 1985*).

Numerous authors have based their conclusions on subjects's stated frequencies of hand decontamination (*Larson and Killien, 1982; Zimacoff et al, 1992*), but others have established that frequency may be over-estimated (*Larson, McGinley and Grove, 1986; Broughall et al, 1984; Williams and Buckles, 1988*). In studies designed to assess knowledge, most nurses appear to recognise the importance of blood and body fluid precautions (*Lynch et al, 1990; Linden, 1991*) but, as *Steere and Mallison (1975)* point out, although the needs of individual patients are predictable, no-one will be able to anticipate exactly what they will find when they initiate clinical contact and this may be why in the clinical situation precautions are overlooked. *Kelen et al (1989)* showed that in emergencies staff failed to wear gloves because they did not have time, although they were aware of the need.

Observation was therefore considered an important method of data collection in this study, supported by interviews and questionnaires to elicit subjects' opinions and knowledge. However, by observation alone it was not always possible to determine the reason behind some actions. Hands would sometimes be washed or gloves donned for a procedure which would then be deferred. It was not possible to state whether these decontaminations should be considered essential or glove use appropriate because the event never occurred. This is illustrated by Subject 163 who washed hands, looked at a drug chart and told the researcher that the intravenous drugs she had been about to prepare had been administered. Conversely some actions which subjects stated they would take in a given situation (vignettes) could not be observed: fortunately sharps injuries are too uncommon to be documented even during a lengthy study such as this. Information concerning emergency situations was scant because a genuine emergency occurred only once (Subject 93). Thus, an incomplete picture sometimes resulted, although overall the use of multiple methods provides more information than any approach in isolation.

**Inter Rater Reliability**

This section of the results documents evidence of inconsistencies between the data collectors.

**Interview**

The interview responses were subjected to bivariate analysis to explore possible associations between category of response and data collector. The following significant associations emerged:-

| | | | | |
|---|---|---|---|---|
| Q3 | Risk of infection to self | $X^2 = 11.928$ | 1*df* | $p < 0.001$ |
| Q9a | Supply of gloves | $X^2 = 4.435$ | 1*df* | $p < 0.05$ |
| Q9d | Provision of sinks | $X^2 = 5.492$ | 1*df* | $p < 0.05$ |

| | | | | |
|---|---|---|---|---|
| Q11 | Sore, dry hands | $X^2 = 6.663$ | 1*df* | $p = 0.01$ |
| Qr5 | Concern about blood splashing | $X^2 = 6.559$ | 2*df* | $p < 0.05$ |

The researcher had collected all data from ITU, so these calculations were repeated using only data from general wards. Most results then ceased to be significant:-

| | | | | |
|---|---|---|---|---|
| Q3 | Risk of infection to self | $X^2 = 0.204$ | 1*df* | $p < 0.001$ |
| Q9a | Supply of gloves | $X^2 = 3.387$ | 1*df* | $p < 0.05$ |
| Q9d | Provision of sinks | $X^2 = 0.024$ | 1*df* | N.S. |
| Q11 | Sore, dry hands | $X^2 = 3.705$ | 1*df* | N.S. |
| Qr5 | Concern about blood splashing | $X^2 = 0.624$ | 2*df* | N.S. |

All other results were non-significant despite the inclusion of data from ITU:-

| | | | | |
|---|---|---|---|---|
| Q1 | Prevalence of infection | $X^2 = 0.306$ | 1*df* | N.S |
| Q2 | Concern about HBV | $X^2 = 2.376$ | 1*df* | N.S. |
| Q5 | Concern about HBV | $X^2 = 1.925$ | 1*df* | N.S. |
| Q6 | Vaccination against HBV | $X^2 = 3.00$ | 1*df* | N.S. |
| Q7a | Pre-registration opportunities | $X^2 = 1.398$ | 1*df* | N.S. |
| Q8a | Post-basic opportunities | $X^2 = 0.342$ | 1*df* | N.S. |
| Q8b | Satisfaction with postbasic opportunities | $X^2 = 1.555$ | 1*df* | N.S. |
| Q9b | Supply of hand decontaminating agents | $X^2 = 2.224$ | 1*df* | N.S. |
| Q9c | Supply of sharps boxes | $X^2 = 1.831$ | 1*df* | N.S. |
| Q9e | Supply of aprons | $X^2 = 3.716$ | 1*df* | N.S. |
| Q10 | Estimated frequency of hand decontamination | $X^2 = 0.148$ | 1*df* | N.S. |
| Q12 | Policy | $X^2 = 0.091$ | 1*df* | N.S. |
| Qr11a | Concern about MRSA | $X^2 = 2.234$ | 1*df* | N.S. |

**Questionnaires**

Response rate was the same irrespective of data collector:-

$X^2 = 0.340$ N.S.

Individual questions were not examined as the questionnaires were not completed in the presence of the researchers.

**Observation**

**Handwashing**

The following significant associations between scores and data collector were obtained:-

| | | |
|---|---|---|
| Duration | W = 2436 | $p < 0.000$ |
| Surfaces Score | W = 8717 | $p < 0.001$ |

The remaining results were non-significant:-

| | | | |
|---|---|---|---|
| Drying score | W = 1781.5 | $p < 0.9152$ | N.S. |
| Disposal score | W = 1667 | $p < 0.4286$ | N.S. |

However, when all four scores were combined into the Amalgamated Handwashing Score, there was no difference between data collectors:-

W = 1105.5 $p < 1.000$ N.S.

**Handrub**

Results were not significant:-

| | | | |
|---|---|---|---|
| Duration | W = 139.5 | $p < 0.3967$ | N.S. |
| Surfaces score | W = 242.5 | $p < 0.1658$ | N.S. |

The choice of agent was not examined for inter-rater reliability as the score was determined by the researcher during preliminary data analysis.

### Workload

Data from Aim 4 demonstrate that workload was genuinely greater in ITU, so observations from this clinical setting were omitted from inter-rater reliability testing. However, there was still a significant association between heavy workload and the data collector on general wards:-

$$W = 1506.5 \quad p < 0.0024$$

This was probably a genuine difference: she collected data on wards which according to the fieldnotes were particularly busy. The researcher collected data on "heavy wards" where fewer clean and aseptic techniques were performed. Ward 3, said to be extremely busy, was quieter than usual because the consultant was on holiday at the time of the data collection.

### Summary and Evaluation: Inter-rater Reliability

The major opportunity for error occurred during observation particularly as it was unacceptable for the two data collectors to monitor the activity of one subject simultaneously. It was expedient for the researcher to collect all ITU data, leading to a difference in duration and surfaces scores for handwashing. Whether or not these were genuine or the result of observer bias cannot therefore be concluded. However, duration was an objective measure so it is likely that a genuine difference occurred. There was no inter-rater reliability effect once incorporated into the Amalgamated Handwashing Score.

Table 6.60 summarises the value of all the instruments employed in data collection.

## TABLE 6.60 The Instruments: an evaluation

| Instrument | Evaluation |
|---|---|
| Interview | Obtained much quantitative and qualitative information, though yielding nominal data only.<br>Valuable information generated |
| Likert Scale | Split half reliability achieved.<br>Cronbach's alpha = 0.6373.<br>Content validity questionable.<br>Open to social desirability effect. |
| Case Study 1 | Did not achieve split half reliability.<br>Cronbach's alpha = 0.3532.<br>Content validity questionable.<br>Construction of Discrimination Index possible. |
| Case Study 2 | Split half reliability achieved.<br>Cronbach's alpha = 0.5106.<br>Content validity questionable.<br>Construction of Discrimination Index possible. |
| Principles of Microbiology | Split half reliability achieved.<br>Cronbach's alpha = 0.5210.<br>Content validity questionable.<br>Construction of Discrimination Index possible. |
| Knowledge of Hand Hygiene Related to Specific Nursing Procedures | Not open to statistical tests of reliability and validity.<br>Achieved content validity. |
| Observation | Yielded a great deal of quantifiable data. It was possible to record frequency of total and essential decontaminations and to construct a sensitive score to assess handwashing technique. A similar score to assess technique when handrub was employed could not be constructed owing to the speed with which events occurred. Some aspects of handwashing technique may have been influenced by observer bias. Hawthorn Effect - probably existed but did not detract from study findings. |
| Ward Facilities Checklist (augmented by Fieldnotes) | A valuable guide to supplies of ward equipment, also drawing attention to variation in ward atmosphere.<br>Not sufficiently rigorous for statistical tests. |
| Ward Atmosphere:<br>Visual Analogue Scale | Data collected systematically only in one hospital.<br>Limitations of the scale therefore difficult to assess. |
| Workload | Appears a valid indicator of levels of clinical activity for each nurse. |
| Dependency | Not a valid or reliable measure of clinical activity in this study. |

# CHAPTER SEVEN

## DISCUSSION OF RESULTS

The extensive literature concerned with HAI, including hazards of parenteral infection to staff, is not matched by research related to the infection control practice of hospital personnel. There is little doubt that patients are at risk of infection disseminated by contact, chiefly via hands (*Casewell and Phillips, 1977; Reybrouck, 1983; Larson, 1988*), or that staff themselves can be placed at risk of parenterally spread virus infections (*Gurevich, 1988; Goodlad, 1991*). It has been established that patients who are immunocompromised and undergo invasive therapies are particularly likely to succumb (*Stamm, 1978*), while degree of exposure of staff to blood and body fluids may increase their risk (*Denes et al, 1978; Gurevich, 1988*), yet the behaviour of hospital personnel in different clinical settings has not been well documented. Difficulties inherent in such research include the need to observe closely without intrusion and to judge behaviour according to established criteria for good practice. This is problematic where such criteria are not well defined, either because they do not exist or vary between countries or institutions. Existing instruments to document appropriateness and technique of hand decontamination do not appear to be as rigorous as desirable, although handwashing has been the subject of research for over twenty years. Gloves and sharps have been studied less often, but considerable work is now being undertaken (see Chapter Four).

Possibly these shortcomings exist because in the past much of this work, conducted by microbiologists or infection control nurses, has been presented in brief journal reports not intended for an audience which would be critical of behavioural research.

Findings are generally judged to indicate poor compliance with key infection control measures (*Sedgwick, 1984; Becker et al, 1990*), but attempts to relate this to knowledge or to enhance performance through educational campaigns have not been particularly successful (*Williams and Buckles, 1988*), possibly because the precise nature and depth of knowledge required by the various professional groups have never been well-established. Lack of motivation and under-resourcing (*Bartzokas and Slade, 1991*) have been suggested as obstacles to good performance but these have been thoroughly explored in relatively few studies. A sense of failure and disillusionment pervade the literature: there lurks an unspoken condemnation of clinical staff by infection control experts apparently unwilling to accept that exhorting doctors and nurses to practise wisely may be unhelpful as they may be prevented from doing so by practical barriers. Nurses are inevitably singled out for the most intense study and criticism because they are the largest workforce within the health service and the group with most direct patient contact.

This study was designed to overcome the shortcomings of previous work within the same field by documenting the behaviour of a single group, nurses, by a nurse researcher aware of the constraints and pressures underlying nursing work. Other groups were deliberately excluded so that the study could not be criticised on the grounds that members of one professional group were sitting in judgement of another, whose performance they were in no real position to comment upon.

Nurses in three different clinical settings were examined to identify factors which might promote or prove detrimental to good practice. Acceptable levels of performance were agreed before commencing main data collection and variables including levels of ward activity and resources were taken into consideration. Multiple forms of data were collected to capture full information including subjects' opinions of HAI, knowledge, clinical performance and local difficulties which could influence practice. Lack of well-developed instruments for data collection detracted to some extent from conclusions: existing tools required considerably greater modification than had been envisaged, so the investigation proved more exploratory than had been planned.

This final chapter continues with a re-consideration of the hypotheses before the detailed results of the study are examined in terms of the aims.

**The Hypotheses**

Hypothesis 1

Nurses employed in ITU will demonstrate greater knowledge and awareness of risks of HAI to themselves and patients than nurses employed in general surgical and medical wards.

It was possible to accept Hypothesis 1 in part. According to their Likert scores ITU nurses did not hold more positive opinions than those on general wards, although they were significantly more likely to believe that their patients and themselves were at risk of HAI. Their knowledge was similar to that of nurses on other wards.

Hypothesis 2

Experienced nurses will demonstrate greater knowledge and awareness of risk of HAI to themselves and their patients than less experienced nurses.

Hypothesis 2 was rejected. Knowledge was similar for both groups, while less experienced nurses had more positive Likert ratings, although they were less likely to consider themselves or their patients to be at risk of HAI.

Hypothesis 3

Nurses employed in a hospital where an infection control nurse is employed will have greater knowledge and awareness of risks of HAI to themselves and their patients than nurses employed in a hospital without an infection control nurse.

The reverse results were obtained. Nurses in Hospital B, without an infection control nurse, had significantly higher scores on three of the knowledge questionnaires (Case Study 1 and 2 and Principles of Microbiology) and higher Likert scores. Nurses in Hospital A were more likely to consider patients but not themselves at risk of HAI.

Hypothesis 4

At times when levels of clinical activity are high, nurses will not perform infection control procedures as frequently or as well as when levels of clinical activity are low.

Hypothesis 4 was partially accepted. As workload increased, decontamination frequency (Rigor Score) increased, as did the number of essential decontaminations, but only in units in Hospital B. Handwashing technique, glovewearing score and safe sharps use were unaffected by workload.

Hypothesis 5

Nurses employed in ITU will perform infection control measures more effectively than those on medical and surgical wards.

Both frequency of hand decontamination and number of essential decontaminations were higher in percentage terms in ITU Hospital B and lowest in ITU Hospital A. Thus the effect of the clinical setting was influenced by the hospital in which the unit was located. Technique was significantly better in ITU regardless of hospital, although this could have been influenced by the data collector.

Glovewearing score was also subject to the interactive effect of Hospital and clinical setting, highest in ITU Hospital B. Unsafe sharps use occurred too seldom for hospital differences to emerge. Incidents of very poor practice were evenly distributed between the hospitals.

Hypothesis 6

Experienced nurses will perform infection control measures more effectively than less experienced nurses.

Hypothesis 6 was rejected. Less experienced nurses washed hands significantly more often and more appropriately. No other significant results emerged.

Hypothesis 7

Nurses in a hospital where an infection control nurse is employed will perform infection control measures more effectively than those in a hospital with no infection control nurse.

Hypothesis 7 was rejected. As discussed in conjunction with Hypothesis 5, when significant results were obtained influence stemmed from interaction between hospital and clinical setting, superior practice emerging in Hospital B, especially ITU.

Discussion will now turn to the detailed study aims, opening with the sociodemographic variables of the subjects.

**Sociodemographic Variables**

Most subjects ($n$ = 151) were less than 36 years of age, with a trend for older, less well-educated nurses to be employed in ITU and medical wards in Hospital A. The sample was atypical in that only 13 (7.51%) were men, less than the 10% quoted in the *National Health Service Handbook (1991)*. However, they were evenly distributed throughout both hospitals and wards. There was no evidence that males were particularly reluctant or unlikely to be included in the study but there were too few to examine the data for the effects of gender.

It was not possible to compare results with those of *Zimacoff et al (1992)* who suggested that females decontaminated hands more often, irrespective of profession.

Most subjects ($n$ = 156, 90.17%) were first level nurses: only one second level nurse was included from Hospital B, where a policy not to employ staff of this grade appeared to operate. Seventy-five nurses (43.6%) held a relevant postbasic qualification, significantly more in ITU, but with no hospital difference. Nurses in Hospital A and ITU were significantly more likely to have been qualified for more than three years. Eighty nurses (46.51%) were experienced according to the study criteria, significantly more in Hospital A. Less experienced nurses were more likely to hold a postbasic certificate. Recruitment of experienced nurses to the study was influenced by the nurse in charge of the ward. Some sisters encouraged participation of junior staff, others of more senior nurses. Although more nurses in Hospital A were classified as experienced, in Hospital B, where experienced nurses were available, they tended to be recommended to the researchers, except on Wards 12 and 13.

From these results it is clear that subjects were not a representative sample of the NHS as a whole or even of their own hospital. This limits generalisability of findings. It also complicates comparisons between the hospital samples.

Possibly the decision to classify those nurses with more than three years employment within their current specialty as experienced was inappropriate. It was taken on the grounds that exposure to the clinical setting was considered essential before subjects could be offered a place on a course. The course was seen to provide the knowledge to support "experience" which according to *Benner (1984)* influences practice. However, "experience" judged in this way could amount to practical "know-how" which need not be supported by understanding.

This is borne out by the results: knowledge was unrelated to experience. Only one significant result was obtained: knowledge of contact precautions was significantly greater for first level nurses. Less experienced nurses washed hands more often and more appropriately. Holding a postbasic qualification appeared to have no effect on knowledge or behaviour, a finding that was surprising, as the ITU course could reasonably be supposed to contain an infection control input.

Attempts to assess ward atmosphere foundered in this study (see Chapter Five). Nevertheless it emerged as a variable which could influence execution of infection control precautions. Its inclusion in future studies is commented upon at the end of the chapter.

**Aim 1 To document facilities available to help nurses prevent HAI through routine procedures including hand decontamination, glove and sharps use.**

The Ward Facilities Checklist, augmented by fieldnotes, drew attention to similarities between the two hospitals which could affect clinical practice or views concerning infection control, suggesting that comparisons between the two were meaningful. Provision of occupational health services and availability of hepatitis B vaccine were similar. Wards of a similar age and design were visited. Architecture is not thought to influence rates of HAI *(McGowan, 1981; Maki et al, 1982)*, but features of ward layout may be influential: provision of sinks may promote handwashing (*Broughall et al, 1984; Kaplan and McGucklin, 1986*) although not all authors agree *(Preston et al, 1981)*.

Provision of sinks was similar in both hospitals and all areas visited with one exception: on corridor wards in Hospital B nurses preparing injections had to walk a long way to wash hands. This could be overcome by use of handrub.

Conversely, the two hospitals differed in a number of respects which must be considered in the interpretation of findings.

In addition to lack of an infection control nurse, Hospital B was without recent infection control policies and the atmosphere between the two hospitals was strikingly different, reflecting *Revan's (1964)* observations. In Hospital A morale appeared low and on some wards there were long-standing staff shortages. Hospital B reflected a generally pleasant atmosphere where individuals took pride in their work. Any staff shortages were temporary. Dissatisfaction occurred where lack of opportunities for promotion meant that to progress up the career ladder nurses would have to move elsewhere.

The phenomenon of ward atmosphere, described by *Orton (1981)* became apparent during fieldwork and was supported by documentation on the Ward Facilities Checklist. On some wards a much happier atmosphere prevailed than on others. As noted in Chapter Five, all had distinct characteristics which would affect the range and scope of nursing practice, including opportunities for patients and staff to develop infection and preventative action necessary.
The Ward Facilities Checklist provided many examples of variable supplies of equipment between wards, corroborating findings by *Gidley (1987)* and *Larson et al (1992).*

Nurses commented on these at interview and differences were reflected in results obtained during observation. These will be discussed in conjunction with the other study aims.

**Aim 2 To investigate nurses' perceptions of HAI: its prevalence, threats to themselves and their patients, educational opportunities regarding HAI and use of effective strategies for prevention**

Each of the topics covered by the interview will be considered in turn, followed by discussion of the Likert Scale. Results from the Ward Facilities Checklist will be incorporated as appropriate.

**Prevalence of HAI**

This was addressed not to tap knowledge, but to determine general awareness of the threat posed by HAI to patients and whether this was influenced by clinical setting. The very sick, particularly those with invasive devices, succumb most often (*Stamm, 1978; Rose and Babcock, 1975*), explaining why, despite some variation in data collection methods, rates are always higher in ITU than general wards (*Daschner et al, 1982; Donowitz, et al, 1982*). ITU nurses did not estimate overall prevalence of HAI any differently from those on general wards, however, although all subjects on Ward 7, where large numbers of immunocompromised patients were treated, rated risks as very high. The results of large scale epidemiological studies suggest that overall ten per cent of hospital patients develop HAI (*Meers et al, 1981*).

On this basis over half the nurses questioned over-estimated prevalence and of these thirty-six (20.81%) vastly over-estimated risks, some mentioning figures as high as 70% for the general hospital population.

There is limited evidence here that nurses' views are coloured by personal experience. Their pessimism is curious in view of their positive opinions concerning infection control. Possibly their concern about HAI, indicated by their requests for infection control updates,is expressed in their belief that excessive numbers of patients succumb to HAI.

**Threats to Patients**

Three quarters of the nurses believed their patients to be at particular risk of HAI. Two possible explanations exist, not mutually exclusive: the effects of morale and those of experience dependent on the clinical setting in which respondents were working.

ITU nurses were significantly more likely to consider their patients to be at risk. Most related this to factors associated with the patient and many drew attention to the number of invasive procedures performed in ITU inevitably placing patients at risk.

There is also some suggestion that particular nurses were especially concerned about infection, as those who over-estimated prevalence were significantly more likely to consider their patients at risk. These nurses tended to have been qualified longer and were more experienced within the specialty.

A difference in opinion emerged between the two hospitals, nurses in Hospital A considering their patients to be more at risk. Resources were generally less good in this hospital.

Reasons given by nurses on general wards were rather vague, frequently pertaining to ward environment rather than factors inherent within the patient. Poor facilities were mentioned and reliance on inexperienced nurses to provide a high proportion of care. This may be related to morale: dissatisfied staff in Hospital A may have tended to cite problems in the workplace as the reason behind infection risks. A difference emerged between the two medical units which appears more related to morale than experience. Medical nurses in Hospital A considered patients significantly more at risk. Six nurses on Ward 7 rated risks to be high, not unreasonably, as they provided care for immunocompromised patients in isolation but only two nurses on Ward 14, catering for a similar client group, considered risks to be high. Morale here was much better than on Ward 7. One possible suggestion, for which there is regrettably no evidence, is that the infection control nurse in Hospital A may have raised staff awareness of risks.

**Threats to Self**

Most nurses (106, 61.28%) did not consider themselves at particular risk of infection from patients. However, there is again some evidence of the "infection conscious" nurse, as those who rated themselves at risk were also more likely to believe their patients to be at risk. Such nurses were often employed in ITU. As before, these nurses had been qualified longer and were experienced.

Although writers such as *Goodlad (1991)* argue that any nurse can develop parenteral infection, there is evidence that individuals performing invasive procedures are at greatest risk and that risk increases with continual exposure over the years (*Denes et al, 1978*). Nurses who had been qualified longest and worked in ITU could therefore be considered correct when they claimed they were at particular risk. There may also be increased risk among those clearing up after doctors (*Collins and Kennedy, 1987*). This also occurred most often in ITU.

Theoretically hospital personnel also face risks of developing classical communicable diseases (*Hyams et al, 1984; Schaechter et al, 1989*), but this was seldom mentioned by subjects and not seen as a particular problem by those on medical wards where patients with tuberculosis were admitted. This supports the view of *Bagshawe et al (1978)*: nurses who frequently encounter infectious patients were thought by these authors to make a more realistic assessment of risks. Such nurses were deemed to provide better care.

A difference emerged between nurses on medical wards between the two hospitals: twelve nurses in Hospital A considered themselves at particular risk compared to four in Hospital B. The researcher was not routinely aware of patients' diagnoses, but the number nursed in isolation because they were infectious seemed higher in Hospital B, supporting the explanation offered by *Bagshawe et al.* Contributing factors could also be the generally superior supply of equipment, particularly gloves, to help prevent infection in Hospital B and its higher morale.

It was implicit or explicit that when talking about risks to themselves, most nurses immediately linked this to hazards from blood and body fluids, a finding that is not surprising given the amount of publicity this has recently received (see *Goodlad, 1991; Sim, 1991).* In those few cases where risks were not attributed to blood and body fluids they were couched in very general terms, suggesting that subjects' concerns for personal safety though genuine, were vague. These nurses seemed to think that threat emanated from bacteria spread by the airborne route which would cause respiratory infection, especially if they were 'run down'. This is in direct contradiction to the literature reviewed in Chapter 2 which conclusively demonstrates that nosocomial Gram negative and staphylococcal infections are spread primarily by direct contact and that this is probably also the major route for respiratory pathogens (*Gwaltney et al, 1978; Leclair et al, 1987; Isaacs et al, 1991*).

*Roth (1957)* in an ethnographic account of life in a sanatorium for tuberculosis patients, commented on the irrationally held beliefs of staff. These were far fewer and less bizarre in the present study, but illustrate the need to assess nurses' existing knowledge and beliefs concerning HAI before attempts are made to change them. This is recommended by *Becker et al (1990).*

Just as illuminating as reasons for considering self to be at risk from infection were subjects' reasons for considering they were <u>not</u> at risk. These suggested that nurses were aware of threats of HAI to immunocompromised patients and recognised that such infection was unlikely to be transmitted to anyone in sound health.

Nurses who did not rate themselves at particular risk did not lack awareness of parenteral infection, but thought risks were effectively contained by high standards. Risks of glove permeability, damage and allergy were never mentioned, although these are well documented ( *Dalgleish and Malkovsky,1988; Korniewicz, 1989; Korniewicz et al, 1989; Kotilainen et al, 1990; Van Rijswik, 1992).*

**Concern about HBV**

Nurses were asked to rate seriousness of HBV on a visual analogue scale. Ninety-three (53.75%) were concerned about HBV and eighty (46.25%) could be categorised as "very concerned" (estimates of over 80% on the VAS). This is borne out by many spontaneous comments concerned with the amount of damage that the virus can cause. Hepatitis B is an unpleasant infection which can result in chronic carriage, although this is by no means inevitable. Liver damage affects a small proportion of individuals (*Main, 1991).* Subjects in this study tended to over-estimate the morbidity associated with HBV, as noted by earlier writers (*Gould, 1985; Kelsey, 1992).* There is a message for authors such as *Goodlad (1991)* and *Trevelyan (1991)* who, by raising levels of awareness to HBV, may increase anxiety to unwarranted levels.

Despite their greater tendency to consider themselves at risk of infection, ITU nurses, who handled blood and body fluids most, were not more likely to be very concerned about hepatitis B. Those who worked on wards where they encountered HBV carriers routinely were not necessarily very concerned, again suggesting that those accustomed to risks hold rational views.

**Immunisation against HBV**

Although an effective vaccine has been available for some years (*Szmuss et al, 1982*), failure to be immunised has been highlighted by numerous authors, through lack of provision by occupational health services mindful of expense (*Goetz and Yu, 1990*) or groundless fear that the vaccine, now obtained by DNA recombinant techniques, may transfer HIV (*Spence and Dash, 1990*).

Most employers in the U.K. make at least some provision for vaccination (*Trevelyan, 1991*), which in both Hospital A and B could be judged good: one hundred and twenty-six (72.83%) of the nurses in this study had been fully immunised and those who had not were either in the process of vaccination or planning to be vaccinated. No negative comments were recorded. This was expected in view of the comprehensive services provided by the occupational health departments. However, the recent campaign of awareness in Hospital A had not resulted in any significant difference between the hospitals. Much of this involved display of posters, documented by the Ward Facilities Checklist. The campaign by *Williams and Buckles (1988)* against HAI adopted this same passive method of disseminating information, illustrating the limitations of the approach.

Even with these relatively high levels of immunisation there is no room for complacency. Some nurses in Wards 6, 7, 13 and 14 had not been immunised, although the nature of these clinical specialties suggested that they could quite frequently be exposed to blood.

**Reported Action on Accidental Exposure to Blood**

The accumulated evidence of many years suggests that exposure of apparently intact skin to blood should be taken seriously, and if necessary followed by prophylaxis, because many seropositive individuals cannot recall injury (*Callender et al, 1982; Polakoff, 1986*) or have been exposed only to minute traces of blood (*Pattison et al, 1974; Polish et al, 1992*), while nurses' hands frequently become abraded (*Ojajarvi et al, 1977*) or cut (*Shagafi et al, 1992*). Despite this evidence, no advice was provided to staff in either hospital of the action to be taken following blood splashing onto intact skin, a curious omission in Hospital A where information was otherwise detailed and widely disseminated. In consequence this material was analysed in conjunction with opinions about infection, although *Kelsey (1992)* analysed these responses as knowledge.

The results of the present study are a cause for concern. Only 13.84% ($n$ = 18) of the one hundred and thirty nurses providing information would report exposure. A further 42.31% ($n$ = 57) would at least look for signs of damage on the hands and take action if it was apparent, but the remainder would take no action beyond handwashing.

When the first two groups were somewhat artificially collapsed into a single "cautious" category to permit statistical analysis against those who would take no action, it was found that no difference existed between them in terms of considering themselves at risk of infection or vaccination.

The question was not analysed in any greater depth because the information, obtained in writing, was often minimal. This topic would have been more usefully explored during interview. It is important, as lack of awareness of the importance of following up exposure to small quantities of blood may result in subclinical infection. It is this asymptomatic reaction to the virus which appears most likely to result in hepatocellular damage *(Main, 1991)*.

**Educational Opportunities**

**Pre-Registration**

Most nurses ($n$ = 129, 74.56%) could recall some pre-registration teaching concerned with infection control other than aseptic technique, though for many details were forgotten. This was unfortunate, as it was not possible to determine whether input had been theoretical or applied and whether psychomotor skills such as handwashing technique had been emphasised. Very few subjects mentioned hand decontamination technique. In contrast to the results of other authors (*Akinsanya, 1982; Courtnay, 1991*) most nurses believed that input had been adequate, although only at the time: more was considered necessary for qualified nurses. Those on surgical wards recalled pre-registration teaching more often than others, perhaps because more were younger and it had been more recent.

**Post-basic Opportunities**

Questions relating to post-basic opportunities yielded some of the most valuable interview data, which also proved to be the most difficult to record as subjects felt so strongly about its need in relation to HAI and had so much to say.

Most could recall opportunities, particularly those who had been qualified longest and ITU nurses, possibly because teachers and managers had concentrated on this group in recognition of the acknowledged high risks in ITU. Some material could have been included during the ITU course, although this was never mentioned.

Irrespective of whether they recalled post-basic opportunities, most nurses were in favour of more on the grounds that input was insufficient to keep abreast of current ideas.

This was most marked among medical nurses who could be overlooked because they are less likely to deal with patients having invasive procedures. However, they deal with patients who are infectious and as the distinction between some of the wards designated medical and surgical in this study was not clear, there appears to be a place for more education for these nurses.

When asked what input they would like, most nurses mentioned regular updates, which have proved popular in other hospitals (*Matthews, 1991*). There was no lack of interest in HAI, supporting the literature (*Ching and Seto, 1990; Gill and Slater, 1991*). Given this level of enthusiasm, the failure of educational campaigns is difficult to explain, unless perhaps subjects are unaware of their own bad habits, as suggested by the observation data of this and other studies (*see Cookson et al, 1985*).

It is notable that where feedback on previous performance is given, handwashing compliance has increased (*Mayer et al, 1986; Conly et al, 1989*), while efforts of infection control nurses to alter practice through ward teaching have been most successful (*Lynch et al, 1990*). Where coercion is employed, resentment may be experienced (*Seto et al, 1991*).

**Effective Use of Resources to prevent HAI**

This data is best considered in relation to the Ward Facilities Checklist, which indicated that despite the availability of a potentially effective infection control policy document in Hospital A, its recommendations were not necessarily operationalised within clinical areas.

According to *Simpson (1991)* the success of an infection control policy depends on the availability of suitable equipment as well as overall presentation, practicality and dissemination among those intended to implement it. In Hospital A the policy generally met these criteria. It was displayed in four of the seven areas visited, had been seen by 67.22% ($n$ = 59) nurses and was comprehensive apart from criteria for glove use and lack of information in relation to blood splashing. Where it failed, it was apparent that the cause lay chiefly in lack of suitable equipment, chiefly gloves and hand decontamination agents.

**Gloves**

Nurses in Hospital A were much more likely to complain about poor supplies of gloves, especially those in ITU and medical wards.

The Ward Facilities Checklist illustrated that supplies were poor in these areas, particularly in Ward 6 where newly delivered stock vanished overnight.

Budgets were held at ward level in both hospitals within a climate of cost-consciousness, but the manner in which disposable supplies were controlled varied. Nurses in Hospital A appeared to be victims of over-zealous budgeting, a situation complicated by their practice of "borrowing" between wards. If budgets had been devolved to ward level to encourage savings, as staff believed, the scheme was evidently failing on the basis that poorly managed wards were achieving a reduction in cost at the expense of those where stocks were maintained. In Hospital B good provision of gloves and other supplies did not appear to result in wastefulness and may have promoted nurses' satisfaction by optimising practice.

Within the literature there is concern that gloves are used wastefully, particularly to protect staff (*Goldmann, 1991*). In the U.S.A there is some evidence that gloves are inappropriately and incorrectly used (*Stringer et al, 1991*), while recently in the U.K. in the popular nursing press it has been suggested that savings could be made specifically in relation to gloves (*Denton, 1991*). This does not indicate that the use of gloves should be abandoned, but that it should be rationalised, particularly employing expensive sterile gloves for procedures where cheaper, non-sterile alternatives would be safe. There is growing evidence that non-sterile gloves could be used more widely, but this is tentative and more work is required before hospital policies are changed (*Anderton and Aidoo, 1991*).

### Hand Decontaminating Agents

In contrast to the situation with gloves, most nurses ($n$ = 131, 75.72%) were satisfied with supplies of decontaminating agents, particularly in Hospital B, where only three complaints were registered. Dissatisfaction was most marked in ITU Hospital A, where the Ward Facilities Checklist showed that the policy had not been properly implemented. This is supported by the results of observation and will be discussed in conjunction with Aim 4.

### Sharps Boxes

Full sharps boxes were noted on Wards 3, 4 and 6 although these were not always wards where unsafe practice occurred or incidents of poor practice in relation to sharps were recorded. Only 12.72% ($n$ = 22) nurses registered dissatisfaction. There were no unfavourable comments from ITU, probably because disposal units were provided at every bedspace.

### Aprons

Few nurses were dissatisfied with supplies of aprons ($n$ = 31, 17.9%). There was no difference between hospitals although they were worn more often in Hospital A.

### Provision of Sinks

Forty-three nurses (24.86%) remarked about poor provision of sinks. Nurses in ITU Hospital A were significantly less satisfied than their counterparts in Hospital B. They justified this by pointing out that, in an ideal situation in ITU, a sink should be provided at every bedspace. This was more a problem in ITU Hospital A than B because handrub supplies were poor.

Conveniently placed sinks are used more than others (*Broughall et al, 1984*) indicating that positioning can influence compliance, although simply providing more sinks does not automatically increase handwashing frequency (*Preston et al, 1981*).

Data from medical and surgical units could not be tested statistically between the hospitals because in Hospital B levels of dissatisfaction in these wards was too low. This was contrary to expectation, as actual provision appeared to be marginally better in Hospital A. In corridor wards in Hospital B drug cupboards were inconveniently positioned in relation to sinks. Possibly nurses' morale could influence comments: those unhappy at work and insecure about performance might feel more inclined to remark adversely on the work environment.

**Sore Dry Hands**

In addition to poor facilities,infection control performance may be reduced by dislike of those provided. In this study 70.52% ($n$ = 122) complained of sore dry hands, which they attributed to harsh agents, usually chlorhexidine. This reflects the findings of *Ojajarvi et al (1977, 1991)*. The problem is not insurmountable, as provision of handrubs with emollients has been well-received by staff while capable of achieving the required bactericidal effect on hands (*Kolari et al, 1989; Newman and Seitz, 1990*).

However, handrub was not mentioned in this study as a means of overcoming the problem, although a few subjects said that they preferred to use it, mainly for convenience, or on wards without chlorhexidine when they wanted a "medicated" agent.

Sore dry hands were cited by *Larson and Killien (1982)* as the main reason for poor handwashing compliance, but in the study by *Larson, McGinley and Grove (1986)* staff who washed hands most often were significantly more likely to complain of soreness and dryness. This appears to be the situation here, as nurses in Hospital B complained significantly more often and decontaminated nearly 5% more often, although statistical analysis with the raw data did not indicate that frequency was different between the two groups, except in ITU. As shown in Chapter Five the relationship between sore, dry hands and frequent decontamination explored on the Likert Scale did not appear to be assessing opinions towards HAI prevention.

Cold weather influences hand soreness (*Larson, McGinley and Grove, 1986; Ojajarvi, 1991*). This could have influenced the findings in this study, as data in Hospital A were collected mainly during the summer and in Hospital B throughout the colder months.

**Nurses' Estimates of their own Hand Decontamination Frequency**

Other authors have consistently reported that nurses over-estimate their hand decontamination frequency (*Broughall et al, 1984; Larson, McGinley and Grove, 1986; Williams and Buckles, 1988*). This was not borne out by the present findings. Only 14.45% ($n$ = 25) over-estimated frequency, though similar numbers under-estimated or could not state frequency. Under these circumstances the use of self-reports of frequency on which to base conclusions appears inaccurate, although this has been attempted (*Larson and Killien, 1982; Zimacoff et al, 1992*). Observation was therefore an important aspect of this study.

**The Infection Control Policy**

Half the subjects could remember seeing the policy in their current workplace, significantly more in Hospital A than B, as anticipated from the Ward Facilities Checklist. Comments about the policy were seldom made by nurses who had seen it in Hospital A, but those in Hospital B remarked critically on its lack of detail. The quality of a policy therefore appears to be regarded as important as availability by nurses. It should be evaluated and updated regularly (*Nystrom, 1991*). There was evidence that this occurred in Hospital A (from the date on the document and discussion with the infection control nurse). Evidence from nurse managers showed that this did not occur in Hospital B.

Close examination of the data showed that ITU nurses were equally likely to have seen the policy: the difference between the hospitals was accounted for by nurses on general wards.

Infection control experts point out that good advice is of limited value unless clinical staff are sufficiently committed to act on it (*Cadwallader, 1989*). In both hospitals evidence from the interview and Likert Scale suggested that nurses were keen to prevent HAI, but clinical commitment is not a replacement for good advice, whether it is supplied in written or verbal form. Many nurses, especially in Hospital B, voiced genuine concerns about infection control precautions which could be answered by reference to a policy or by telephoning an approachable clinical specialist nurse. However, in Hospital A where this service was provided, there were clear indications that in many local areas the policy was not implemented.

The most outstanding occurred on Ward 7, where the nurses had developed their own protocol for the isolation of severely immunocompromised patients, in direct contravention of recommendations. Their procedure excluded gloves, perhaps to reduce ordering or because supplies were poor. This could have been overcome by more supervision from the infection control nurse, whose duties include policy implementation and education (*Worsley, 1988*), both functions depending on good communication (*Wilson, 1990; Seto et al, 1991*). In this respect the size of Hospital A could have reduced the effectiveness of the infection control nurse. This is known to occur when responsibility exceeds more than 200 beds (*Haley et al, 1985*). Hospital A was much larger than this, employing the greatest nursing workforce in Europe.

**Concern about MRSA**

Fifty-three (41.4%) of the nurses responding to this question formed a "very concerned" category (over 70% on the VAS). Their main fear was spreading MRSA to susceptible patients. Having to take time off work was a secondary consideration. This supports the questionnaire studies of *French (1987)* and *Tuffnell (1988)*, although according to these authors, nurses were more concerned than in this study about their own health in relation to MRSA. These responses, provided in written form, suggested vague concerns about MRSA which individuals appeared to find difficult to express in writing.

**Opinions Expressed on the Likert Scale**

Higher scores (out of 100) indicated positive opinions towards the prevention of HAI. Mean score for the sample was 80.97%, with a comparatively narrow range (63-100), suggesting generally favourable views. As discussed in Chapter Five, this could have been a reflection of social desirability.

*Linden (1991)* identified favourable opinions toward glove use in ITU, although the scores in this study were slightly lower than those recorded here. They are also higher than in the study by *Williams and Buckles (1988)*, which failed to produce any demonstrable change in opinion despite a series of interventions intended to increase handwashing compliance.

Opinions were significantly more favourable in Hospital B, where morale was higher, but there was no association with clinical setting. These findings may have been influenced by the lower response rate in Hospital B (65.11%). The ward environment in Hospital B bore no relationship to Likert scores, but first level nurses and those holding postbasic qualifications had higher scores. These results must be interpreted with caution, as only one nurse in Hospital B was a second level nurse and she did not return a questionnaire.

Interview findings were not associated with Likert ratings in any systematic or meaningful fashion.

**Aim 3 To investigate nurses' knowledge of infection control and HAI**

Although the infection control experts providing advice on content validity believed that clinical nurses could reasonably be expected to know the subject matter examined on each of the four questionnaires, the results suggest otherwise.

Knowledge was highest for blood and body fluid precautions but, at 66.78% for the sample overall, could not be judged particularly good given that nurses would encounter the situation depicted in Case Study I every day. Knowledge of practical hand hygiene (61.14%) was slightly less good, while knowledge of contact precautions (55.15%) and theoretical principles (49.11%) were distinctly poor.

The results of Spearman's Rank Correlation Coefficient suggested that high scores on one questionnaire were not associated with high scores on the others, with two exceptions. There was a highly significant association between good scores on Case Study I and the Principles of Microbiology ($p < 0.005$) indicating that an understanding of theoretical concepts was closely associated with knowledge of blood and body fluids precautions.

There was a less significant ($p < 0.05$) association between Case Study 2 and the Principles of Microbiology, suggesting that appreciation of theory was more modestly related to knowledge of contact precautions.

However, when the Mann Whitney test was used to compare nurses' knowledge assessed on one questionnaire with the results of all the others in turn, significant results were obtained, suggesting that a subject who scored highly in one area was also likely to score highly in the others. All results were highly significant ($p$ <0.000), except the relationship between the Principles of Microbiology and Knowledge of Hand Hygiene for Specific Nursing Procedures ($p$ <0.05).

Knowledge was unrelated to experience and not associated with any of the sociodemographic variables recorded except that first level nurses had significantly better knowledge of contact precautions than second level nurses.

The results of the each of the questionnaires will be examined in turn below.

**Case Study 1 Blood and Body Fluid Precautions**

Knowledge was significantly better in Hospital B and not associated with clinical setting, although the observation data indicated that ITU nurses were exposed to blood and body fluids more often. This supports the earlier finding that experience was unrelated to knowledge and research by *Ho Yen et al (1984)* who found no difference between nurses' knowledge of HBV according to clinical setting. The results do not agree with those of *Kelsey (1992)* who established that knowledge of HBV was significantly better for nurses working in a high risk area (renal unit) than that of nurses in general wards, although this did not appear to be related to any special educational input. Thus the result of the present study is worrying in view of the potential risk to staff from HBV presented by their inner city client group.

More than a quarter of the one hundred and thirty nurses responding (26.93%, *n* = 35) were unable to state all the precautions they would take when handling blood routinely, although 87.69% (*n* = 114) had some appreciation of HBV carrier status. A quarter were unable to state all the actions which should be taken following a needlestick injury and nearly half under-estimated the risks of urethral catheterisation to the patient, although these are well documented (*Clifford, 1982*). Qr2b, designed to assess nurses' knowledge of the need for universal precautions, yielded particularly interesting data. 60% (*n* = 78) knew that all blood and body fluids should be handled as though infectious, but many subjects qualified this statement: they knew that this was the "correct" response, but they stated that if they knew a patient to be a proven carrier of HIV or HBV, they would take more care during routine contact. This question may therefore have assessed attitudes as much as knowledge. The way in which nurses responded says much for their honesty. Sadly it also explains why, despite all that has been written, patients with HIV (*Searle, 1987*) and HBV (*King, 1990*) still feel ostracised.

*Goodacre (1987)* pointed out that much is being asked of surgeons when they are exhorted to perform invasive procedures exposing them to blood, when members of the public have received leaflets as part of a government campaign intended to increase awareness of risks associated with sharing toothbrushes and razors. Perhaps too much is also expected of nurses.

Intensive campaigns to promote glovewearing (*Lynch et al, 1990*) and to reduce sharps injury (*Becker et al, 1990*) have accompanied a media campaign of awareness against HBV (*Goodlad, 1991*), yet hospital staff are constantly reminded that parenterally spread viruses are of low virulence, so their personal risk is not high. These messages are conflicting, leading to a situation where knowledge and opinions are difficult to disentangle.

**Case Study 2 Contact Precautions**

Knowledge of contact precautions for this sample seems particularly low, especially as all nurses throughout the two hospitals would need to know how to reduce the spread of MRSA. Outbreaks had occurred in both hospitals and all three clinical settings. Almost half the sample were unaware that MRSA is spread by contact, apparently believing that significant dissemination occurred via the airborne route judging from their responses to Qr10d in which many over-estimated the need to confine patients to a single room and Qr10g where the role of masks to reduce infection was frequently over-estimated. According to Qr10b, 93.07% ($n$ = 121) subjects knew that handwashing could reduce spread, yet fewer (80.76%, $n$ = 105) recognised the vital role played by gloves. The reasoning behind this is obscure. It does not appear rational, especially as 41.4% ($n$ = 53) would be very concerned if they became MRSA carriers, chiefly on behalf of their patients.

Very little information concerning contact precautions exists within the literature. It has not been a popular topic for nurses undertaking research, perhaps because it is seen to be the province of experts.

However, in Hospital B no expert nurse existed to provide advice and the policy was not only dated, but lacked detail. In Hospital A, where a detailed policy was available, protective isolation was known to be poorly executed and many concerns about practical details were expressed by nurses at interview. There is a role here for reassurance as well as the provision of knowledge and close supervision to ensure that policies, when they exist, are implemented.

**Principles of Microbiology**

Knowledge was significantly higher in Hospital B. Some questions were answered particularly badly: Qr12 (ability to name nosocomial pathogens), Qr14 (portals of entry), Qr16 (epidemiology of HAI) and Qr18 (body fluids containing HBV). The relevance of Qr12, Qr16 and Qr18 to the practical situation could be questioned, but it is a matter of concern that only 42.63% ($n$ = 55) knew the main routes by which pathogens achieve access and of grave concern that only 20.31% ($n$ = 26) knew which body fluids contain infectious HBV particles.

To argue strictly in terms of what nurses "need" to know is to take a utilitarian stance. Given the interest shown by subjects to infection in this study, it is apparent that most would welcome the opportunity to increase knowledge. This might increase confidence, itself a beneficial effect even if there was no immediate impact on observed practice. Apart from the Knowledge of Hand Hygiene for Specific Nursing Procedures, none of the questionnaires was associated with perceptions of favourable ward atmosphere, but it is likely that satisfaction with performance would increase if nurses were given more opportunity to learn about microbiology.

**Knowledge of Hand Hygiene for Specific Nursing Procedures**

Scores for the Knowledge of Hand Hygiene for Specific Nursing Procedures were not high and lower than those reported by *Linden (1990)*. There was no difference between hospitals or clinical setting, although ITU nurses wore gloves more often and performed more of the procedures on a regular basis. There is some belief that need to wash hands is obviated when gloves are worn (*Lynch et al, 1987*) and that handwashing is such a routine event that the need to perform it is overlooked when responding to questions designed to assess knowledge (*Kelsey, 1992*). This may have happened in this study, as the column for handwashing was frequently not ticked, especially when subjects recognised the need to wear gloves.

**The relationship between individual questions concerned with knowledge**

These results throw some light on nurses' performance with the questionnaires overall. There is some indication that if subjects knew the route of transmission they also appreciated the concept of viral or bacterial carriage. For example, those who demonstrated adequate knowledge concerning the general need for blood and body fluid precautions (Qr1) also displayed knowledge concerning the HBV carrier and the need for universal precautions. Similarly, those who knew that MRSA is spread primarily via contact also demonstrated adequate appreciation of the concept of bacterial carriage. In other cases there was little consensus between the results of questions exploring different aspects of the same topic.

**Relationship between Knowledge and Opinions**

It would be reasonable to suppose that nurses with the most favourable opinions towards the prevention of HAI would also demonstrate the most knowledge. This was borne out in the results of this study, where no significant results were obtained when Likert scores were correlated with knowledge, a finding not supported by *Williams and Buckles (1988).* In their study attitudes did not improve with a temporary increase in knowledge following education campaign.

**Aim 4 To observe three essential elements of nurses' clinical infection control practice: hand decontamination, glove and sharps use**

This section will be organised as follows: a consideration of the frequency, appropriateness and technique of hand decontamination, gloves and sharps use, then the more informally observed elements of behaviour: aprons and rings. As with the questionnaire data, results were sometimes influenced by hospital, clinical setting or the hospital in which a particular unit was located.

**Hand Decontamination**

**Frequency**

Frequency of hand decontamination over two hours was 6.67 for the sample overall and therefore 26.68 decontaminations per eight hour shift. This exceeds the widely quoted criterion of ten times per shift (*Simons and Garner CDC, 1986*) but does not approach the very high figures observed by *Ojajarvi et al (1977)* in a burns unit.

This excessive level of decontamination is considered damaging rather than beneficial through tendency to abrade skin increasing rates of bacterial carriage (*Maki, 1986; Ojajarvi, 1991*). However, even at the much lower levels found here, three quarters of the nurses complained of sore, dry hands. Frequency was somewhat higher than the rates reported by other authors recorded by direct observation (*Larson, McGinley and Grove, 1986*) and by accurate monitoring systems (*Broughall et al, 1984,; Williams and Buckles, 1988*). Direct comparison is difficult however, as all these studies were confined to one particular setting and the length of the shift was not always stated. In some studies the range of frequencies has been considerable (*Leonard, 1987, 1 - 135*), but in this study is much narrower (0 - 21). Two nurses failed to decontaminate, as in the study by *Sedgwick (1984)*, where staff must have been aware of the reason for observation. The rather high frequencies reported in the present study yet failure of two individuals to decontaminate suggests variable reaction to the Hawthorn Effect. Performance was not associated with any of the sociodemographic variables recorded.

### Appropriateness

Two schemes were employed: the Rigor Score, which in accordance with the strict criteria of *Albert and Condie (1981)*, stipulated that hands should be decontaminated following every patient contact and the Liberal Appropriateness Score based on work by *Broughall et al (1984)*, who acknowledged that some nursing procedures would probably result in heavier contamination than others. The philosophy behind the approach may reflect the clinical areas in which the two research teams collected data.

*Albert and Condie (1981)* conducted their study in ITU, where brief contact may be sufficient to cause transfer of sufficient numbers of bacteria to cause infection among very debilitated patients (*Casewell and Philips, 1977*). *Broughall et al (1984)* collected data on general wards. In this environment handling a wide range of equipment may result in contamination of nurses' hands, but its clinical significance has yet to be determined (*Sanderson and Weissler, 1992*). As long ago as 1975 *Steere and Mallison* pointed out that need to decontaminate hands may vary with circumstance. Today, with more invasive procedures keeping alive even more vulnerable patients, this may be even more significant. Possibly the criteria used to judge acceptable practice should vary with clinical setting. Both sytems used to judge appropriateness will be considered in turn.

**Rigor Score**

Compared to the widely quoted work of *Albert and Condie (1981)* which was probably intended to draw attention to the problem by illustrating poor levels of compliance, the nurses in this study performed even less well. Overall, 28.78% patient contacts were followed by decontamination, compared to 42% in the earlier study. This figure is similar to frequencies quoted by *Larson et al (1992)* in a Third World country where facilities were very poor and rates in ITU before educational interventions intended to improve compliance (*Conly et al, 1989: 29%; Graham, 1990: 32%*). Frequencies from the two intensive care units reflected the extremes of practice: 22.92% in Hospital A and 29.54% in Hospital B. An important distinction, between the present study and others is that only nurses were observed, instead of all members of staff.

As nurses decontaminated hands more often than other personnel, the overall rates reported by these authors may detract from nursing performance, so here practice could be even less good than it first appears.

**Liberal Appropriateness Score**

When essential decontaminations were considered, performance for this sample is seen in a better light (49.85%), but hands were still decontaminated only half the time this was really necessary. The extent to which the unit exerted its influence depended on the hospital in which it was located. The Liberal Appropriateness Score was apparently highest in ITU Hospital A (13.1), but as a percentage frequency it was lowest (35.37%). This indicates that most opportunities to decontaminate were missed in this unit even though most were performed. This is a reflection of levels of ward activity: ITU Hospital A was the busiest area visited (see Aim 4). Lack of suitable decontamination agents could also have influenced this finding. Overall, results compare unfavourably with those of *Taylor (1978)* who reported that decontamination occurred after 59% activities categorised as "dirty" on the Fulkerson Scale. However this author acknowledges that the scale was somewhat arbitrary in the classification of nursing actions, but does not discuss whether bias occurred such that clean or dirty activities were over-reported, so further comparison is not meaningful. Compared to the results of *Larson, McGinley and Grove (1986)* reporting a frequency of eight times per shift from oncology wards, results here are more favourable. On Ward 14 (oncology) by extrapolation of data collected over two hours 16.48 decontaminations over eight hours would have occurred.

**Factors affecting hand decontamination appropriateness and frequency**

Less experienced nurses performed essential handwashes more often. No association between number of years qualified, professional qualification or holding a postbasic certificate could be detected, so this significant finding is difficult to interpret and could have occurred spuriously.

**Choice of Agent**

Choice of appropriate hand decontaminating agent failed to correlate with scores relating to the other components of handwashing and handrub use because it was higher : 11.11 for the one hundred and seventy-one who decontaminated. Appropriate choice was made significantly less often in ITU Hospital A, where handrub should have been supplied but was not. Use of handrub was heaviest of all in ITU Hospital B, where nurses applied it between performing different procedures on the same patient, when they would not have had time to walk to the nearest sink. As Liberal Appropriateness Score rating increased, score for choice of agent declined ($p < 0.05$) suggesting that it was sometimes used as a shortcut because there was insufficient time for a handwash, but the subject realised that decontamination was essential. Lack of suitable resources could explain why a lower percentage of essential decontaminations occurred in ITU Hospital A and why nurses registered so many complaints about poor provision of sinks at interview.

Choice of appropriate agent was lower on surgical wards, depressed by the unusually low scores from Ward 2 (9.97) and Ward 11 (9.34).

On Ward 11 bar soap was in evidence and used twice, reducing scores. On Ward 2 it appeared that handrub replaced soap after procedures which would contaminate hands heavily. This occurred on other wards, but not to such a marked extent. Personal preference appeared to play an important role. This is illustrated most clearly by subjects 41 and 110 who both used handrub exclusively, sometimes inappropriately, commenting to the researcher that they particularly liked it.

Thus it appears that although choice of agent was generally appropriate, with very few instances when bar soap or no agent were applied, scores could occasionally be depressed for a number of reasons, relating to inappropriate supply, personal choice or a combination of the two.

Choice of agent could not be related to any of the sociodemographic variables recorded, although handwashing frequency was significantly higher for less experienced nurses, perhaps because they performed fewer complex procedures when handrub would legitimately be required. Where failure to implement the policy in Hospital A occurred this seemed to be the result of managers' cost-consciousness rather than apathy on the part of clinicians and although three quarters of the sample disliked the agents supplied, there was little evidence that they avoided them by providing their own soap, using bar soap or only water.

*Ojajarvi (1980)* suggests that as alcohol destroys bacteria more effectively than most other agents, it could be used routinely in clinical areas, but this was against the policy in Hospital A.

## Technique of Hand Decontamination

### Handwashing

Each of the components of handwashing will be discussed individually, then together as the Amalgamated Handwashing Score.

### Duration

Although it has been suggested that duration must be linked to thoroughness because more time allows more hand surfaces to be contacted by the agent (*Bowell, 1992*), duration was not incorporated into *Feldman's Criteria (1969)* or added when the scale was validated by *Larson and Lusk (1985).* Most authors have assessed duration independently of technique reporting only modest correlation (0.05 *Larson, McGinley and Grove, 1986*), but owing to its correlation with the other components of handwashing process, duration was incorporated into the Amalgamated Handwashing Score in this study. However, this does not prevent it being compared separately to the results of other studies.

For the sample overall, duration was 6.56 seconds, therefore falling short of the ten seconds minimum recommended by *CDC (1986)* and figures quoted by other authors (*Quaraishi et al, 1984, Broughall et al, 1984; Graham, 1990*). These authors also quote very wide ranges in duration, not reflected in data from the present study, where the longest handwash lasted 28 seconds, once for one subject, whose overall mean was 18 (Subject 118).

Neither *Quraishi et al (1984)* or *Broughall et al (1984)* could demonstrate that longer duration occurred in association with 'dirty tasks', a finding replicated here, as there was no association between Liberal Appropriateness Score and duration.

In this study duration was similar for nurses in both hospitals, but significantly greater in ITU. This could have been the result of observer bias or a genuine difference in performance, perhaps because ITU nurses had more time. The second explanation is plausible, because duration was timed objectively from the point when agent first touched hands to the commencement of rinsing, as recommended by other authors (*Quraishi et al, 1984; Larson and Lusk, 1985*) and neither data collector reported difficulties.

**Thoroughness (number of surfaces decontaminated)**

Handwashing was equally thorough between the two hospitals, but significantly better on ITU. Again, this could reflect observer bias, because one data collector had gathered this data. Where a hand surface was omitted this was the interdigital surface, as in the study by *Linden (1990)*. Comparison with *Taylor's* much more detailed study *(1978)* in which the performance of individual nurses was closely examined, is not possible.

**Drying**

All nurses made some attempt to dry hands and the score for the sample overall was 9.51, with ITU nurses drying significantly better. There was no hospital difference.

As drying is incorporated into Feldman's Criteria when assessed in others studies and the separate subscores are never presented, comparison with other findings is not possible, except the study by *Gidley (1987)* where drying was reported as poor.

Drying helps to remove bacteria remaining after washing (*Sprunt et al, 1973*), a phenomenon which may be particularly important when less effective agents are used (*Ansari et al, 1991*). From these results it appears that the best drying occured among nurses supplied with the most effective agents: although there was no handrub in ITU Hospital A, chlorhexidine was supplied.

**Disposal**

Disposal score was 9.12 for the sample overall. Although the two methods of analysis show slight disagreement, with ANOVA indicating a significant hospital effect not revealed by the Mann Whitney test, there is little doubt that superior scores were obtained in ITU, especially in Hospital B. This supports fieldnote comments, which drew attention to the use in both units of open plastic bags to collect rubbish at every bedspace, although they were sometimes handled during disposal. Pedal bins were provided in all areas, but broken in five wards in Hospital A (ITU, 2, 3, 4, 6) compared to only two in Hospital B (9, 11). Under these circumstances it is surprising that there was no greater difference between the two hospitals, particularly as handrub, which obviates disposal, was more available in Hospital B. Its availability in ITU Hospital B may explain why performance here was better than in ITU Hospital A. Disposal has been reported poor by one other author (*Gidley, 1987*).

**The Amalgamated Handwashing Score**

Mean score for this measure of technique was 8.64 for the sample overall, with no difference between hospitals. However, performance was significantly better in ITU, with no evidence of observer bias once all four components were united. Technique could thus be considered moderately good with room for improvement for this sample: even on ITU score was no more than 9.73 on average although a few individuals scored maximally (12). None of the sociodemographic variables recorded were significantly associated with technique, but as handwashing performance fulfils the criteria of a psychomotor skill as defined by *De Tornyay and Thompson (1987)* it is open to improvement. This has never been systematically attempted, although *Williams and Buckles (1988)* found a short-lived increase in frequency having subjected staff to an intervention which included a film demonstrating technique. Technique itself was not assessed by these authors.

Other authors assessing technique have employed Feldman's Criteria (*Taylor, 1978; Sedgwick, 1984; Larson, McGinley and Grove, 1986; Gidley, 1987*), either in the original or validated form. This scale was not considered to be a meaningful indicator of technique on the basis of literature reviewed and pilot studies which suggested, as in another recent study (*Linden, 1990*), that it was too complex for fieldwork.

Possibly the relative simplicity of this scale compared to that of Feldman is responsible for a difference in findings: other authors have concluded that technique is poor. In published articles scores are not shown, however, so the way in which poor performance is actually defined is not known.

Other authors commenting on technique remark on its variation between different members of staff, but stability for the individual (*Taylor, 1978; Sedgwick, 1984*). As *Larson, McGinley and Grove (1986)* watched the same twenty-two individuals over months this phenomenon may have become readily apparent to them. In the present study, there was occasional evidence of highly idiosyncratic behaviour, such as the tendency of Subject 118 to drip all over her patient and Subjects 41 and 110 to use only handrub, but the observation period of two hours was not sufficient to reveal trends unless very eccentric.

In the present study handwashing technique was not associated with frequency, but in the study by *Larson, McGinley and Grove (1986)* the two were closely associated, good performance on one accompanying good performance on the other.

**Handrub**

As much research concerning frequency, duration and technique of decontamination has occurred in the U.S.A. where until recently alcohol appears not to have been widely used, it is inevitable that handrubs have been less well studied. Adoption of Feldman's Criteria in the UK may have perpetuated this omission, because the checklist does not incorporate a scoring system for handrub. Most work concerning handrub other than bactericidal effectiveness has taken place in Finland by an author committed to improving compliance through increased acceptability of agent (*Ojajarvi et al, 1977, 1991*).

Alcohol substitutes with emollients are seen to provide this alternative by other authors (*Kolari et al, 1989; Newman and Seitz et al, 1990*) but they do not necessarily increase compliance (*Mayer et al, 1986; Graham, 1990*). *Ojajarvi's* success in enhancing hand hygiene may be related to the personal contact maintained between the author and the wards: she visited daily throughout lengthy trials and participated in testing agents during fieldwork so that staff would be encouraged to take part. The trials conducted in 1977 suggest that technique is different when handrub is used because of its lack of viscosity. It "slipped through the fingers" so easily that duration was reduced, and therefore fewer surfaces reached.

This had implications for bactericidal effectiveness, which before intervention was only 60% compared to 100% after an intervention to enhance technique.

In the present study no overall score for handrub use could be calculated because the three components: choice of agent, duration and number of surfaces decontaminated, failed to correlate. Duration was 4.81 seconds for the sample overall, with no significant difference between hospital or clinical setting. This was significantly shorter than handwashing duration, confirming the earlier finding by *Ojajarvi et al (1977)*. However, surfaces score for handrub was slightly, but not significantly greater than for handwashing, 8.6 for the sample overall. There was no significant difference between hospital or clinical setting. As with handwashing, the interdigital surface was most often omitted. This finding does not support *Ojajarvi's* work, as thoroughness with handrub could have been expected to be significantly lower than with handwashing, especially as duration was lower.

*Ojajarvi's* original trials were conducted with alcohol, although in later work incorporation of emollients was suggested to reduce skin damage and bacterial count as well as increasing compliance (*Ojajarvi, 1981*). On the basis of their laboratory findings *Larson, Eke and Wilder (1987)* suggest that incorporation of emollients into alcoholic agents may increase contact time by delaying drying. Handrub supplied to Hospital A and B contained emollients. Findings in the present study may reflect difficulty recording events accurately when handrub was used, because episodes could occur suddenly and were usually over quickly. The amount of agent used by the nurses was not assessed, although this is likely to vary under laboratory conditions (*Larson, Wilder, Eke et al, 1987*) and less alcohol tends to be used than other agents in the clinical situation (*Doebbeling et al, 1992*). Researchers in these studies noticed that some nurses appeared to use much more handrub than others. Subject 107 in the present study used such large quantities that she dried her hands on a paper towel on several occasions, while Subject 117 used such tiny amounts that it was impossible to measure duration and only the palms were covered. This anecdotal evidence suggests that when handrub is used, duration, technique and quantity are particularly closely associated.

Failure to calculate an overall score for handrub technique meant that each component had to be examined separately for possible association with frequency and the Liberal Appropriateness Score. One significant result was obtained: as frequency increased, thoroughness decreased. This could be construed as further evidence that, when rushed, nurses tend to use handrub. There was no relationship with any of the sociodemographic variables recorded.

## Glove Use

The number of times gloves were needed, the number of times they were worn and inappropriate use were documented. The glovewearing score was calculated to show not only whether gloves were worn when they should have been, but whether the correct type, sterile or non-sterile,was chosen.

## Number of times gloves were needed

Gloves were needed much more often in ITU than on surgical or medical wards, with no significant difference between hospitals. In ITU they were needed to perform endotracheal suction and to protect the nurse from blood and body fluids. Outside ITU, need was considerable on Ward 7 for protective isolation and on Ward 3 where complex dressings were performed and nurses frequently handled stomas and drainage bags. Calculating an overall figure for glove need for the total sample ironed out these considerable fluctuations and presented an inaccurate picture.

## Number of Occasions Gloves were Used

On Wards 13 and 14 glove use mirrored glove need (comparison of means) showing that use was appropriate, with no wastage. In ITU Hospital B use slightly exceeded need, but in all other areas uptake fell short of need. The difference could be slight (Ward 2) or considerable. It was most marked on Ward 7 because of the protocol the nurses had developed to look after patients in protective isolation, which did not involve gloves, although according to hospital policy, sterile gloves should have been worn.

These severely immunocompromised patients could therefore have been placed at considerable risk, especially as the mean surfaces score for handrub use was only 6.67, the lowest for any of the wards where data were collected. In other areas failure to wear gloves was most likely to place the nurse at risk. It is noteworthy that gloves were always worn for endotracheal suction, in contrast to the study by *Quraishi et al (1984)* which showed that glove use for this procedure was sometimes omitted.

**Inappropriate Glovewearing**

Inappropriate glovewearing occurred seldom in the present study, agreeing with findings by *Linden (1991)*, not *Stringer et al (1991)*, who reported throughout their data collection period that almost half the gloves supplied to wards were wasted. Inappropriate use occurred most often in ITU. This is not surprising, as gloves were present at every bedside, which was not the case on wards. Also pertinent is the fact that on ITU gloves were regularly needed and the nurses would try to anticipate when they would be required. Occasionally they may have expected a patient to be bleeding or soiled and worn gloves in readiness, resulting in apparently wasteful use. The researcher might document this as inappropriate, not knowing the patient or the nurse's thoughts. *Steere and Mallison (1975)* pointed out that although it is possible to identify "at risk" procedures with given patients, this cannot be predicted on all occasions. The desire of the nurses to protect themselves is laudable, given that it is impossible to predict which patients may be carrying parenteral viruses (*Gurevich, 1988; Gordin et al, 1990, Havilcheck et al, 1991*), the discomfort which glovewearing can cause (*Jenner, 1990-b; Linden, 1991*) and the need today to treat all patients equally (*Searle, 1987*).

Adopting universal precautions as recommended by *Wilson and Breedon (1990)* helps to overcome risks when blood is unexpectedly encountered. This is cited as a major problem in the literature. *Gurevich (1988)* describes typical scenarios in which the needs of a bleeding patient take precedence over the need of staff to protect themselves, while *Kelen et al (1989)* have observed this during emergency procedures. Subject 7 in the present study had developed hepatitis B having attended a bleeding patient without gloves, although her skin was apparently intact and she had not sustained a sharps injury. During an emergency in ITU Hospital B a doctor became heavily contaminated with blood when he too lacked time to put on gloves.

*Goldmann (1991)* claims that the use of gloves to avoid infection risks to patients has never been fully evaluated. This is no longer correct (see *Larson, Bobo, Bennett et al , 1991)* although it must be acknowledged that they will not reduce endogenous infection to the same extent as cross-infection (*Donowitz, 1986)*. However, their value in helping to protect staff from parenteral infection seems justified on the basis of risk evaluated in Chapter Four, while observation in this study indicates they were seldom used wastefully.

**Glovewearing Score**

Glovewearing score was significantly higher in Hospital B. This was almost certainly related to availability of gloves in general, but especially sterile gloves, which were supplied in small quantities and scarcely used in Hospital A. Thus, when the wrong type of glove was chosen in Hospital A, this was because non-sterile replaced sterile gloves, not because sterile gloves were used wastefully, as observed by *Denton (1991)*.

According to *Anderton and Aidoo (1991)*, non-sterile gloves afford sufficient protection when enteral feeds are prepared and administered to neonates, a procedure for which sterility is usually considered important. It is possible that non-sterile gloves may be safely used in other traditionally aseptic procedures, but more work is needed to determine this. At present it is recommended that sterile gloves are used to perform endotracheal suction *(Yanelli and Gurevich, 1988)*, particularly as intubated patients are at such high risk of developing lower respiratory tract infection *(Johanson et al, 1972)*. However,in Hospital A, non-sterile gloves were always employed. The otherwise comprehensive infection control policy in this hospital provided no guidance on glove use, an unfortunate omission as no national guidelines are available. Some authors are in favour of national guidelines for glove use *(Linden, 1991)* or infection control generally *(Nystrom, 1991)*, while others consider they are of limited value unless sufficiently flexible to be adaptated to local need *(Simpson, 1991)*. Hospital A and B show extremes of practice in the absence of expert advice. In Hospital A, lacking adequate resources, nurses "made do" with equipment available, either unaware, uncaring or resigned to its inappropriateness. In Hospital B, where adequate equipment was readily available and a higher degree of professionalism appeared to exist, resources were husbanded wisely. The nurses sometimes commented on the good range of gloves available:-

Subject 111 *"It's good really. There are sterile for the suction and the other type for when you take blood. We have different sizes and thickness (gauge). You need thicker gloves for protection with blood".*

This comment reveals not only a positive attitude towards resources available, but an appreciation for how they should be deployed.

In both hospitals nurses always worn gloves to withdraw blood. However, blood stained surfaces and equipment, including a floor and chair, were noted on the Ward Facilities Checklist in ITU Hospital A. This was not satisfactory in view of evidence from *Bond et al (1981)* and *Hanson et al (1989)* that HIV and HBV can survive for considerable periods if protected with plasma and echoes the results of a study by *Forseter et al (1990)* in which bloodstained equipment was used routinely without cleaning by clinical staff.

**Other Issues related to Glove Use**

A number of poor practices related to glove use have been reported (*Stringer et al, 1991*), but were seldom observed during data collection in this study.

One incident of continuous glovewearing occurred. Subject 110 handled a range of clean and dirty equipment in the immediate patient environment and distant parts of the ward. She had removed and cleaned the inner tube of a tracheostomy, a procedure which could lead to heavy hand contamination and cross-infection to other patients sufficient to result in widespread Gram negative colonisation throughout ITU (*Lowbury et al, 1970*). Her behaviour can therefore be regarded as an example of poor practice, placing vulnerable patients at risk and lack of appreciation of the role of gloves in the original procedure for which they were worn.

In contrast, the single episode of glovewashing witnessed (Subject 117) represented an attempt to cope under very unfavourable circumstances and cannot be dismissed as unjustifiably poor practice given the particular circumstances in which it occurred, although pathogens can be isolated from gloves (*Polish et al, 1992)* and are not easily washed off (*Doebbeling et al, 1988).* The nurse was performing a complex aseptic procedure for which gloves were indicated when a patient in a neighbouring bed for whom she was also responsible slipped from his chair to the floor. In rushing to his aid, she decontaminated her hands with handrub, then again on return to the original patient. This incident, though anecdotal, illustrates the need during this type of observation to judge all clinical actions in context.

None of the issues of glove use examined bore any association with sociodemographic variables. When glove use was examined in relation to hand decontamination only one significant finding emerged: nurses with high scores for thoroughness with handrub had high glovewearing scores. Since it occurred in isolation, this finding may be spurious.

Overall it may be concluded that gloves were usually worn when necessary by this sample except on Ward 7, seldom wasted and that choice of correct glove probably depended on availability.

**Sharps Use**

A sharp instrument, usually an injection needle, was handled by one hundred and forty-four (83.23%) nurses at least once, and up to five times within two hours by the same individual. There was no difference in frequency with hospital or clinical setting.

Criteria for safe sharps practice were more easily determined for this study than hand decontamination or glove use, as national guidelines exist (*Gwyther, 1989*). The Ward Facilities Checklist showed that sharps boxes of the approved type were available on every ward, although at least one was full on Wards 3, 4 and 6, in Hospital A. Recapping, known to be associated with injury (*Wormser et al, 1984*) occurred on three occasions, once on Ward 6 and twice by the same nurse on Ward 7.

The occasions of unsafe disposal occurred on Wards 12 and 13, where there was no problem with sharps boxes. Neither of these incidents has any rational explanation. Neither is there any rationale for the four incidents of poor practice specifically related to sharps. Two occurred in Ward 3, where a sharps box was known to be full and two nurses inserted either hands or a pen to force down the contents. Why they did not fetch a new box from the ample store available on the ward is unclear.

In Hospital B, ITU and Ward 9 appeared to have outstandingly professional nurses, and to have good supplies of equipment, but one nurse on each inserted hands into a sharps box although there was space to drop in the needles they were discarding.

The incidents of poor practice provide potent evidence that for at least some nurses, Hawthorn Effect was minimal, as it is difficult to believe that they did not realise that they were behaving unsafely. The presence of syringes on the floor of ITU Hospital A is further evidence of careless practice.

The occasional grossly unsafe practices witnessed by the researchers do not concord with the otherwise careful sharps handling and disposal performed by the same individuals. It appears that although usually good, occasional intractably poor practice occurs and the difficulty encountered by authors such as *Becker et al (1990)* attempting to improve compliance, is easy to appreciate. As there is no special technique to be learned when handling or disposing of sharps, campaigns to improve technique through retraining do not seem to provide the answer.

**Aprons**

Protective clothing does not play the same role in reducing infection in general wards as in specialist units *(Babb et al, 1983)* and is not essential when entering ITU although often worn for this purpose *(Nystrom, 1981)*.

Apron use was not formally documented for the nurses in this sample, but it was noticeable that they were worn more often in Hospital A than B, although not changed between individual patients as recommended *(Curran, 1991)*. According to the Ward Facilities Checklist they were available in all areas visited except Ward 10. There were no differences at interview between dissatisfaction with supplies reported between hospitals or clinical settings.

This information was collected as part of the researchers' attempt to paint a full picture of nurses' perceptions of resources available to help them practice optimally and which might influence their opinion of ward atmosphere.

## Rings

Although bacterial counts are higher beneath rings (*Hoffman et al, 1985*) there is evidence that with careful handwashing they may be reduced to levels similar to those when no rings are worn (*Jacobson et al, 1985*). These trials were conducted under tightly controlled laboratory conditions when a good standard of decontamination could be achieved.

A high proportion of nurses in Hospital A wore several rings which were not removed to perform clean or aseptic techniques. As the results of the Amalgamated Handwashing Score demonstrated that even the mean handwash in this hospital achieved only 8.44 points out of a possible 12, it could reasonably be concluded that such behaviour might constitute an infection risk to vulnerable patients. More trials under field conditions are needed to determine the possible hazards associated with ringwearing.

Among nurses there is an unspoken belief that the wearing of rings (other than wedding bands) constitutes "unprofessional" behaviour. This is reflected in the results of the Likert Scale: all nurses indicated that rings should not be worn, although in practice most in Hospital A did not behave according to their own perceptions of good standards.

## Watches

In Hospital A a high proportion of nurses wore wrist watches which they did not remove to perform clinical procedures. No studies concerning this behaviour could be found.

However, if a ring is sufficient to harbour large numbers of bacteria on the skin beneath, as indicated by *Hoffman et al (1985)*, the strap of a watch might harbour more, because it covers a much larger surface area and so the wearing of wrist watches might possibly represent a higher infection risk than rings.

**Aim 5 To examine the influence of workload and dependency on nurses' infection control practice**

Workload (number of clinical contacts) appeared to be a more valid indicator of levels of nursing activity in this study than the more traditional dependency measure approach (see Chapter Six).

Workload was highest in ITU, Hospital A and, contrary to expectation, was as high in some surgical wards as in ITU Hospital B. There was considerable variation between wards and the same area visited on different days. This conflicts with the findings by *Doebbeling et al (1992)* showing that levels of clinical activity in ITU tend to remain unchanged. Workload was not influenced by sociodemographic variables.

**Hand Decontamination**

Need to decontaminate increased with workload, as predicted (see *Doebbeling et al, 1992*), but frequency did not significantly increase. However, with the Liberal Appropriateness Score, a different picture emerges. As workload increased, the number of essential hand decontaminations which should be performed inevitably increased and on ITU, particularly in Hospital B, more were performed.

Handrub was more often used with higher workloads, especially on ITU, but technique of handwashing was unchanged, suggesting that its performance may be dictated by habit, as suggested in the literature.

**Glove Use**

As workload increased gloves were more often required in ITU and were worn more often, but glovewearing score was unaltered. This suggests that nurses in Hospital B, who had the choice of sterile and non-sterile gloves, continued to select them appropriately whether busy or not. Too few nurses wore gloves inappropriately for this to be examined in conjunction with workload.

**Sharps Use**

As discussed under Aim 4, handling and disposal of sharps use were generally good, frequency of use increasing with high workloads, but there were occasional indicators of extremely dangerous practice which bore little obvious relationship to other factors. When the data were inspected, there was no indication that unsafe practice occurred at times when nurses were particularly busy.

**Dependency**

Results from the dependency measure did not concord with those from workload and there was evidence that it was not applied in the same manner by different nurses, as conflicting results were sometimes obtained from the same patient, whose condition appeared unchanged. The dependency measure was too insensitive for use on ITU and did not provide a valid comparison between ITU and general wards because there were always fewer beds in ITU.

However, one significant result was obtained: as dependency increased, handwashing technique deteriorated. Even though dependency may not be a very meaningful reflection of how busy individual nurses are in purely clinical terms, it could be a reflection of how busy they perceive themselves to be. If they felt under pressure they may have washed hands less well. This suggestion is made cautiously,because dependency data were provided by the nurse charge of the ward, who was not necessarily the subject observed.

The findings of this study suggest that workload has a degree of effect on infection control practice, supporting a conclusion by *Haley and Bregman (1982).* This has implications for educational programmes and choice of agent for routine use. When nurses are very busy it may be unrealistic to expect them to increase overall frequency, but good practice can be maintained by encouraging them to recognise opportunities for essential decontamination. They can be taught good technique and reassured that this need not deteriorate when busy.

Finally they could be supplied with handrub for routine use. This is more convenient if within easy reach. Moreover, if technique is sufficiently good for handrub to reach all hand surfaces, bactericidal effectiveness will be enhanced because the performance of alcohol would then be superior to that of soap and water. Incorporation of Chlorhexidine into the lotion would add residual effect, compensating for failure to increase frequency.

**Aim 6 To document how knowledge and opinions of infection control are translated into clinical practice**

In this section the relationship between knowledge of each of the areas of infection control is discussed in terms of its association with opinions and clinical practice. In a final model the interactive effects of hospital, clinical setting, knowledge and workload on behaviour are examined.

**Relationship between knowledge, opinions and clinical practice**

Knowledge of blood and body fluid precautions was not associated with any of the clinical behaviour observed, but nurses with superior knowledge of contact precautions performed essential decontaminations significantly more often, although there was no relationship with technique.

Knowledge of the principles underpinning infection control was associated with better performance of technique: this effect was more highly significant than that of clinical setting. However, the Knowledge of Hand Hygiene for Specific Nursing Procedures, bore no relationship to behaviour. This questionnaire was presented to subjects last, when they had already devoted a considerable amount of time to answering questions. The rather low levels of knowledge displayed for some subjects may reflect poor completion through haste.

Opinions assessed by the Likert Scale had no measurable association with clinical practice. This supports the conclusion of *Williams and Buckles (1988)* who found no association between positive attitudes and handwashing performance before and after their educational campaigns to improve compliance.

In the same study increased knowledge paralleled increased frequency, but the effect declined after six months. The results do not concur with those of *Linden (1991)* who could find no relationship between knowledge and compliance with glove use, but reported the Likert Scale to be a positive predictor of compliance with protocols for glove use. Nurses who believed patients to be particularly at risk performed more decontaminations overall and essential decontaminations. ITU nurses who also believed their patients to be especially at risk scored more highly on Case Study 1.

The findings of this study provide evidence of only tenuous links between opinions, knowledge and behaviour as discussed below. Opinions with the Likert Scale bore no relationship, but this may be related to limitations of the scale rather than genuine lack of association.

**The Final Model: Interactive Effects of Hospital, Unit, Workload and Knowledge on Clinical Practice**

These variables had provided significant findings, so they were incorporated into a final model to examine interactive effects and to determine which was the most significant.

Nurses with higher knowledge scores for contact precautions performed significantly more essential hand decontaminations. Performance of handwashing technique was superior on ITU, and had an interactive effect with knowledge of the theoretical principles underpinning infection control. Opinions of infection control assessed with the Likert Score were related to knowledge but not clinical practice, a finding opposed to the results of previous studies (*Williams and Buckles, 1988; Linden, 1991*).

**Summary of the Study Overall**

The study represented an attempt to compare the effects of the knowledge and opinions of nurses employed in different hospitals and clinical settings on their observed infection control practice, taking into account resources and levels of clinical activity (workload). Data were obtained from two hospitals, one with, the other without an infection control nurse. Most of the hypotheses generated for the study were rejected. Although patients and nurses in ITU are at greater risk of infection (*Rose and Babcock, 1975; Stamm, 1978; French and Cheng, 1991; Denes et al, 1978*) ITU nurses were not more likely to obtain higher scores on a Likert scale designed to elicit opinions toward infection prevention, although they were more likely to consider themselves and their patients to be at risk. Knowledge was similar for nurses in different clinical settings. Nurses in the second hospital, lacking an infection control nurse, scored significantly higher on three of the knowledge questionnaires (blood and body fluid precautions, contact precautions and Principles of Microbiology). This finding was unexpected as the infection control nurse has an established role in education (*Worsley, 1988*). Nurses in the first hospital, which was less well equipped to prevent HAI, were more likely to consider their patients, but not themselves to be at risk of infection.

Workload was associated with an increase in frequency of hand decontamination (more opportunities to decontaminate arose), particularly in ITU Hospital B, but the technique of handwashing and glove and sharps use remained unchanged. *Taylor's (1978)* data suggested that handwashing was not strongly affected by levels of ward activity, but in a more tightly controlled study increased workload was associated with a decline in performance (*Haley and Bergman, 1982*).

It was hypothesised that ITU nurses would perform infection control precautions more effectively than those in general wards in view of the higher risks. Although frequency of decontamination was similar, more essential decontaminations were performed in ITU. However, data from the two units were disparate: the best practice for the entire sample was obtained in ITU Hospital B and the least favourable in ITU Hospital A. Decontamination technique was better in ITU regardless of hospital, although the effect of observer bias here cannot be ruled out. Sociodemographic variables had little effect on any of the data collected.

It was possible to examine the interactive effects of knowledge, opinions, hospital, clinical setting and workload on behaviour, but few significant results emerged. However, nurses with higher scores for knowledge of contact precautions performed more essential decontaminations and the superior performance of technique witnessed on ITU was also associated with higher scores for knowledge of the theoretical principles of microbiology. Some statistical manipulations with ANOVA were not possible because numbers in particular categories were too low despite the relatively large size of the overall sample. The unique atmosphere of the different hospitals and wards could have been reflected in the nurses' professionalism and influenced findings, but this data was collected systematically only in Hospital B. Although an infection control policy existed in Hospital A it was not always fully or correctly implemented, particularly in relation to supplies of equipment, yet in the absence of guidance in Hospital B, resources were used sensibly.

This result concords with the observation by *Cadwallader (1989)* that commitment to infection control must be reflected in the performance of clinical staff, regardless of the expert advice they receive.

**Recommendations for future research**

From the present study, there appear to be tenuous links between ward atmosphere and the clinical performance of infection control precautions which could not be fully explored. A future study could examine this relationship in greater depth, involving a small number of nurses in one ward or unit as in the study by *Larson, McGinley and Grove (1986).* The scoring systems to evaluate quality, frequency and appropriateness of handwashing, glove wearing and sharps use would be those developed in the present study on the grounds that the method of observation was practical, valid, and had scope for testing inter-rater reliability. The use of handrub requires refining. This could be undertaken in advance of the main study, possibly employing video equipment to capture more complete and accurate data. The method of assessing ward atmosphere would need refining. As in previous research, more qualitative methods, perhaps interviews, might be employed, particularly in view of the nurses' readiness to discuss prevention in this study. With a smaller sample observed on repeated occasions over a longer period of time it would be possible to look in greater depth at the effect of observer presence, idiosyncrasies in individual behaviour and the availability of equipment in clinical areas, which from the present study, appear linked to those infection control precautions actually performed.

Having conducted a second, more detailed descriptive study, establishing rapport with the nurses on one ward, it would be possible to undertake a third study to assess the effects of an intervention on nursing performance. On the evidence of the literature (see *Lynch et al, 1990; Becker et al, 1990; Matthews, 1991*) and the above findings, the intervention would consist of short, informal ward-based teaching sessions geared towards increasing practical as well as theoretical knowledge of hand decontamination, glove and sharps use with opportunity to ask questions, voice concerns and discuss practical difficulties. As an important part of the intervention nurses would receive instruction in handwashing and handrub techniques since psychomotor performance appears a greater barrier to performance than lack of theoretical knowledge. Clinical performance would be rated using the scoring systems devised above and staff would be given feedback as this provides encouragement (*Conly et al, 1989*). Evaluation of the sessions would be provided by the nurses. Monitoring rates of nosocomial infection before and during the intervention would provide some indication of its efficacy in microbiological terms, if compared to a similar ward without intervention.

The findings of the study reported here relate to only three clinical settings, but there are many others where infection control should be a priority. Studies to explore nurses' clinical practice within these settings could be undertaken.

# APPENDICES

| HOSPITAL | WARD | STUDY No. |
|---|---|---|
| | | |

# OBSERVATION SCHEDULE. APPENDIX I

| PROCEDURE | HAND DIS (1) | | | | GLOVES | | | HAND DIS (2) | | | SHARPS | | | | | | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Y | N | Agent | T | S | NS | NO | Y | N | Agent | T | R | NR | Bin | N | I | |
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Procedure - precise description e.g. pulse taking, removal of catheter.

Hand dis (1) = before procedure, hands disinfected.

Y = Yes

N = No

Agent = Agent used

T = Time in duration

Gloves

S = Sterile

NS = Not sterile

NO = Glove not worm

Hands dis (2) = after procedure

Sharps

R = Resheathed

NR = Not resheathed

Bin = Sharps straight into bin after use

N = Sharps into straight into bin

I = Any interruptions in procedure

Comment - typical comments -

Nurse wearing ring, only one glove worn, nurse's skin became splashe with blood.

## APPENDIX 1 FULKERSON'S SCALE (FOX et al 1974):

1. Sterile or autoclaved materials.
2. Thoroughly cleaned or washed materials.
3. Materials not necessarily cleaned but free from patient contact (e.g., papers, nursing station).
4. Objects contacted by patients either infrequently or not expected to be contaminated (e.g., furniture).
5. Objects intimately associated with patients, but known to be contaminated (e.g,. patient gowns, linen, dishes, bedside.
6. Minimal, limited contact with patient (e.g., shaking hands, taking pulse).
7. Objects not in contact with patient secretions.

---

8. Patient contact in which secretions or mouth, nose, rectum, etc. are touched.
9. Materials contaminated by patient urine.
10. Direct contact with patient urine.
11. Materials contaminated with faeces.
12. Direct contact with faeces.
13. Materials contaminated with secretions or excretions from infected sites.
14. Direct contact with secretions or excretions from infected sites.
15. Direct contact with infected patient sites (e.g., wounds, tracheostomy).

'Clean' activities : 1 - 7

'Dirty' activities: 8 - 15

## APPENDIX 1 FELDMAN'S OBSERVATION CHECKLIST (1969):

### Table 1. Feldman's criteria

**Used soap**
2 - visible lather
1 - contact with soap but no lather
0 - no contact with soap

**Used continuously running water**
2 - did
0 - did not

**Positioned hands to avoid contaminating arms**
2 - held hands down so that water drained from fingertips into sink
1 - held hands parallel with arms so that water drained from hands to sink
0 - held hands so that water drained onto arms

**Avoided splashing clothing floor**
2 - no splashing
1 - minimal splashing
0 - vigorous splashing

**Rubbed hands together vigorously**
2 - vigorous rubbing
1 - minimal rubbing
0 - no rubbing

**Used friction on all surfaces**
2 - dorsal, ventral, interdigital
1 - one or two of the above
0 - did not use friction

**Rinsed hands thoroughly**
2 - all surfaces, dorsal, ventral, interdigital
1 - one or two of the above
0 - did not rinse

**Held hands down to rinse**
2 - did
0 - did not

**Dried hands thoroughly**
2 - dried all surfaces
1 - dried one or two surfaces
0 - did not dry

**Turned tap off with paper towel**
2 - did
0 - did not

## APPENDIX 1 . PRINCIPLES OF MICROBIOLOGY:

**Confidential Questionnaire.**

Study No:

Unit:

Hospital:

Please answer the following questions as fully as you can. There is no time limit. Further clarification can be sought if necessary.

1. State 6 micro-organisms specifically responsible for causing infection in hospital.

2. i. List the main ways micro-organisms are spread in hospital.

   ii. Place a cross (x) against the mode of spread on your list for 2i which you consider the most important method of spread.

3. List the main ways through which micro-organisms gain access to the patient's internal tissues.

4. Which types of patient do you think are at particular risk of developing infection ? Please give reasons.

5. Provide a definition of cross infection.

6. Please rank the following in the order in which you consider they most commonly occur in hospital: -

   Surgical wound infections.

   Chest infections.

   Urinary tract infections.

7. Distinguish between the following two concepts : -

   Colonisation (carriage of micro-organisms).

   Infection.

8. i. State the differences between gram negative and gram positive bacteria.

   ii. Please give an example of each.

9. i. The Human Immunodeficiency virus [HIV] has been reported to be transmitted from:-

| | Yes | No | Don't know |
|---|---|---|---|
| Saliva | | | |
| Faeces | | | |
| Breastmilk | | | |
| Vaginal secretions | | | |
| Blood | | | |

ii. The hepatitis B virus has been reported to be transmitted from:-

| | Yes | No | Don't know |
|---|---|---|---|
| Saliva | | | |
| Faeces | | | |
| Breastmilk | | | |
| Vaginal secretions | | | |
| Blood | | | |

10. Which hand-washing/cleansing agent (s) are recommended for use on your ward/unit ?

11. The information above is provided in a number of different ways during basic and post basic nursing education. Please state how you knew the information you have provided.

Thank you for your help. If you are unsure of the answers to some of the questions and require feedback it can be provided.

## CASE STUDY [1].

Mr. Charles Ives, admitted to your ward/unit last week, was unconscious but has since made steady progress, though still requiring intravenous fluids. He is an insulin-dependent diabetic, at present reliant on the nursing staff for his injections, though usually able to do this for himself.

Please answer the following questions.
There is no time limit.
Further clarification can be provided if necessary.

1. What precautions would you take when handling Mr. Ives' blood and bod. fluids ?

2. i. Five days after admission it is discovered that Mr. Ives is a carrier for the Hepatitis B antigen. Explain what is meant by the words underlined.

   ii. Would the precautions you take with his blood and body fluids now differ from those you described above ?
   Please give reasons.

3. To provide themselves from exposure to HIV, nurses should take the same precautions as they would for hepatitis B.

Please tick: -

True.

False

Not sure

4. Mr. Ives' intravenous infusion has been discontinued, but the cannula site is still oozing. Your skin becomes splashed with blood as you apply a dressing. What action would you take ?
Please give reasons.

## CASE STUDY 2 .

Mr. Percy Grainger, a patient on your ward/unit is found to be carrying methicillin-resistant Staphylococcus aureus (MRSA) in his wound.

Please answer the following questions.

There is no time limit.

Further clarification can be provided if necessary.

1. Why is MRSA considered such a problem in hospitals ?

2. Bacteria can be spread from one person to another in various ways.
   Please indicate which of the following you consider most important in the spread of MRSA by placing a tick beside each item (s).
   Parenteral (bloodborne) route.
   Airborne (droplets e.g. sneezing, coughing).
   Faecal - oral.
   Contact.
   Insect vectors.

3. The following list consists of a number of nursing actions which may be taken to prevent spread of MRSA from patients who are infected/colonised to others in the same ward/unit. Please indicate on the list below which you consider: -

   A - Very useful ]
   B - Moderately useful ] in preventing spread of infection.
   C - Pointless ]

   Comments are welcome.

a). Wearing gloves when attending to Mr. Grainger.

A B C

b). Washing hands.

A B C

c) Double-bagging Mr. Grainger's linen.

A B C

d) Putting Mr. Grainger in a single room with the door open.

A B C

e). Putting Mr. Grainger in a single room with the door shut.

A B C

f). Bathing Mr. Grainger daily in chlorhexidine. (hibiscrub).

A B C

g). Wearing a mask.

A B C

h) Wearing a cotton gown.

A B C

i) Wearing a plastic disposable apron.

A B C

j). Wearing overshoes.

A B C

k). Wearing a covering over your hair.

A B C

l) Providing Mr. Grainger with disposable crockery and cutlery.

A B C

m). Allowing only one nurse per shift to attend to Mr. Grainger.

A B C

4. i. Routine swabs are taken from members of staff. You are told that you have become a nasal carrier of MRSA. Please indicate on the scale below your degree of concern: -

0 50 100

Not at all concerned Extremely concerned

ii. What would worry you (if anything) about carrying MRSA ?

5. Mr. Grainger's family are anxious about the 'special treatment' he is receiving (because of MRSA). How would you justify your nursing actions to them ? (Refer to the list for question 3).

## APPENDIX 1

Questionnaire Assessing Nurses' Knowledge of Appropriate Hand Protection for Specific Nursing Procedures.

Adapted from Linden 1990

| | Clean gloves | Sterile gloves | Hand- washing | | Neither gloves nor hand-wash | Don't know |
|---|---|---|---|---|---|---|
| | | | before | after | | |
| Emptying urine drainage bags. | | | | | | |
| Handling soiled linen. | | | | | | |
| Administering intravenous drugs. | | | | | | |
| Endo-tracheal tube suction. | | | | | | |
| Catheterizing a patient. | | | | | | |
| Applying a dressing to an infected wound. | | | | | | |
| Nursing a patient with burns. | | | | | | |
| Washing a patient | | | | | | |
| Nasogastric suction | | | | | | |
| Performing mouth-care | | | | | | |
| Handling chest drains. | | | | | | |
| Withdrawing arterial blood samples | | | | | | |

## APPENDIX I: OPINION QUESTIONNAIRE.

Questionnaire Assessing Nurses' Attitudes to Infection Control Measures Relating To Hand Protection, with [Attitude Scale of 5 [Strongly Positive] to 1 [Strongly Negative].

(Adapted from Linden 1990, Becker et al 1990).

| | Strongly agree | Agree | Uncertain | Disagree | Strongly disagree |
|---|---|---|---|---|---|
| Some infection control measures are too demanding to adhere to. | 1 | 2 | 3 | 4 | 5 |
| Patients should have high standards of hygiene even if the nurses must spend more time on each procedure. | 5 | 4 | 3 | 2 | 1 |
| Frequent hand-washing makes your hands sore. | 1 | 2 | 3 | 4 | 5 |
| Strict adherence to control of infection procedures is a luxury which the busy nurse can seldom afford. | 1 | 2 | 3 | 4 | 5 |
| Even if all nurses observed the correct procedures wherever necessary, cross infection would not be significantly reduced. | 1 | 2 | 3 | 4 | 5 |
| Hospital-acquired infections only cause minor illnesses. | 1 | 2 | 3 | 4 | 5 |
| Recapping needles protects the nurse from infection. | 1 | 2 | 3 | 4 | 5 |
| More training in infection control is needed for nursing staff. | 5 | 4 | 3 | 2 | 1 |
| Hospital infection courses are necessary for infection control nurses but not all nursing staff. | 1 | 2 | 3 | 4 | 5 |
| There is always available time to wash hands efficiently. | 5 | 4 | 3 | 2 | 1 |
| If a nurse suspects a colleague of an unhygienic practice, he or she should explain the error to them. | 5 | 4 | 3 | 2 | 1 |
| Nurses need to continually read current literature on infection control | 5 | 4 | 3 | 2 | 1 |

| | | | | | |
|---|---|---|---|---|---|
| Little more can be done to further reduce cross-infection in hospital. | 1 | 2 | 3 | 4 | 5 |
| Leaving needles uncapped puts staff at risk of infection even when a disposal box is used. | 5 | 4 | 3 | 2 | 1 |
| To touch urine without the protection of gloves would be very unpleasant. | 5 | 4 | 3 | 2 | 1 |
| Skin contact with blood is not a serious enough health risk to warrant glove-wearing. | 1 | 2 | 3 | 4 | 5 |
| The risk of transmission of Hepatitis B from a patient with an undiagnosed infection on my ward/unit is minimal. | 1 | 2 | 3 | 4 | 5 |
| It is repellant to accidentally touch the blood of a patient without wearing gloves. | 5 | 4 | 3 | 2 | 1 |
| Glove wearing is uncomfortable and difficult to maintain. | 1 | 2 | 3 | 4 | 5 |
| I would be very anxious about the risks of cross-infection if my patient suffered from HIV. | 5 | 4 | 3 | 2 | 1 |
| Some contamination of the hands with blood is inevitable when caring for patients | 1 | 2 | 3 | 4 | 5 |
| It would be preferable to wear gloves whenever there is any contact with a patient's body fluids. | 5 | 4 | 3 | 2 | 1 |
| Gloves are worn to protect the nurse rather than the patient. | 1 | 2 | 3 | 4 | 5 |
| All nurses should attend refresher courses in infection control to maintain standards. | 5 | 4 | 3 | 2 | 1 |

## APPENDIX 1 . INTERVIEW SCHEDULE:

### CASE STUDY I:

Confidential

Study No.

Ward/Unit

Hospital

1. What percentage of hospital patients develop infection ?

2. Do you think that patients on your ward/unit are at particular risk of developing infection ?

   Yes

   No

   Don't know

   Probe

3. All nurses are at some risk of developing infections from patients. Do you think this risk is especially high on your ward/unit ?

   Yes

   No

   Don't know

   Probe

4. Do you consider awareness of the risk of infection to be high on your ward/unit ?

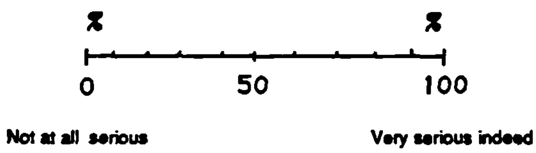
Yes

No

Don't know

Comments

5. i. I am going to show you scale and on it I would like you to indicate how serious you think hepatitis B is.




ii. Before qualifying did you receive any information about protecting patients from infection ?

Yes

No

Can't remember

Specify

iii. Was this information adequate ?

Yes

No

Don't know

Comments

6. i. Before qualifying did you receive any information about protecting patients from infection ?

Yes
No
Can't remember
Specify

7. i. Since qualifying have you received any information about protecting yourself from infection ?

Yes
No
Don't know
Comments

ii. Was this adequate ?

Yes
No
Don't Know
Comments

If no: - What else would be helpful ?

8. Are resources /equipment for preventing infection readily available on your unit ?

Gloves
Handwash agents
Sharps bins
Ward layout with sinks

9. How often do you think you wash/cleanse hands per shift ?

10. Have you seen the infection control policy on this ward/Unit ?

Yes
No
Don't know

11. Is there anything else you would like to say/ask ?

Thank you for your help

## APPENDIX 1. SOCIODEMOGRAPHIC DATA SCHEDULE:

Confidential

Study No.

Ward/Unit

Hospital

| | | | |
|---|---|---|---|
| 1. | Qualifications - professional | RGN | SEN |
| | | ENB Certificate | |
| 2. | Qualifications - academic | GCSE / 0 levels | |
| | | A' levels | |
| | | Degree | |
| | | Other | |

3. Years qualified.

4. Length of time working on this ward/unit.

5. Previous employment.

6. Age.

APPENDIX 2

Hospital ------------------

Ward ------------------

Unit ------------------

Study No ------------------ Grade -----------

Time of observation --------------------

Day of week --------------------

Result of Dependency Measure ----------------

## APPENDIX 2

## Observation Schedule

No. Ward/Unit Grade

Activity

| | | | | | | |
|---|---|---|---|---|---|---|
| Hands disinfected | Yes ☐ | No ☐ | Interuption ☐ | | | |
| Agent | Hibisol ☐ | Hibiscrub ☐ | Wall Soap ☐ | Barsoap ☐ | None ☐ | Not seen ☐ |

Time (seconds)

| | | | | | |
|---|---|---|---|---|---|
| Surfaces | Dorsal ☐ | Palmar ☐ | Interdigital ☐ | Not seen ☐ | |
| Drying | Hands dried thoroughly ☐ | Not thoroughly ☐ | Not dried ☐ | Not seen ☐ | Not relevant ☐ |
| Pedal bin | Used correctly ☐ | Not used correctly ☐ | Not seen ☐ | Not relevant ☐ | |
| Gloves | Yes ☐ | No ☐ | Worn continually ☐ | Boths hands ☐ | One hand ☐ |
| | Sterile ☐ | Unsterile ☐ | Gloves washed ☐ | | |
| Sharps | Recapped ☐ | Not recapped ☐ | Not relevant ☐ | Interuption ☐ | |
| | Into bin ☐ | Not into bin ☐ | | | |

Comments.

CLEAN/DIRTY

APPENDIX 2

Confidential — Study No.

Unit — Hospital

* Please answer the following questions.
* There is no time limit.
* Further clarification can be provided if necessary.
* Remember that some questions the 'correct ' answer is a matter for debate.

CASE STUDY 1.

Mr. Charles Ives, admitted to your ward/unit last week, was unconscious but has since made steady progress, though still requiring intravenous fluids. He is an insulin-dependent diabetic, at present reliant on the nursing staff for his injections, though usually able to do this for himself. He has an indwelling Foley catheter.

1. What precautions would you take when handling Mr. Ives' blood and body fluids ?

2. i. Five days after admission it is discovered that Mr. Ives is a carrier for Hepatitis B. Explain what is meant by the words underlined.

   ii. Would the precautions you take with his blood and body fluids now differ from those you described above ? Please give reasons.

3. To protect themselves from exposure to HIV, nurses should take the same precautions as they would for hepatitis B.
Please tick: -

True.

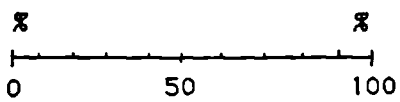
False

Not sure

4. You have just given Mr. Ives his injection and you have sustained a needle-stick injury. What action would you take ?

5. You have removed Mr. Ive's intravenous infusion but the cannula site is still oozing. Your skin becomes splashed with blood as you apply a dressing. Would you take the same precautions as above ? Please give reasons.

6. Remembering that Mr. Ives has an indwelling Foley catheter, use the scale below to estimate how much you think he is at risk of developing a urinary tract infection.




7. Laboratory tests reveal that Mr. Ive's urine contains 'gentamicin resistant klebsiella'. What is the meaning of this term ?

CASE STUDY 2

Mr. Percy Grainger, a patient on your ward/unit is found to be carrying methicillin-resistant Staphylococcus aureus (MRSA) in his wound.

8. Why is MRSA considered such a problem in hospitals ?

9. How is MRSA spread ? Please tick:-

Mostly by air
Mostly by contact
Mostly by insect vectors

10. The following list consists of a number of nursing actions which may be taken to prevent spread of MRSA from patients who are infected/colonised to others in the same ward/unit. Please indicate on the list below which you consider:-

A- Very useful ]
B- Moderately useful ] in preventing spread of infection.
C- Pointless ]

a). Wearing gloves when attending to Mr. Grainger.
A B C

b). Washing hands.
A B C

c) Double-bagging Mr. Grainger's linen.
A B C

d) Putting Mr. Grainger in a single room with the door open.
A B C

e). Putting Mr. Grainger in a single room with the door shut.
A B C

f). Bathing Mr. Grainger daily in chlorhexidine. (hibiscrub).
A B C

g). Wearing a mask.
A B C

h) Wearing a cotton gown.
A B C

i) Wearing a plastic disposable apron.
A B C

j). Wearing overshoes.
A B C

k). Wearing a covering over your hair.
A B C

l) Providing Mr. Grainger with disposable crockery and cutlery.
A B C

m). Allowing only one nurse per shift to attend to Mr. Grainger.
A B C

11 Routine swabs are taken from members of staff. You are told that you have become a nasal carrier of MRSA. Please indicate on the scale below your degree of concern: -

% %

0 50 100

Not at all concerned Extremely concerned

ii. What would worry you (if anything) about carrying MRSA ?

GENERAL QUESTIONS ABOUT INFECTION.

12. State 4 micro-organisms specifically responsible for causing infection in hospital.

13. i. List the main ways micro-organisms are spread in hospital.

ii. Place (x) against the mode of spread on your list for 13i which you consider the most important means of spread.

14. List the main ways through which micro-organisms gain access to the patient's internal tissues.

15. Which types of patient do you think are at particular risk of developing infection ? Please give reasons.

16. Please rank the following in the order in which you consider they most commonly occur in hospital:-

Surgical wound infections.

Chest infections.

Urinary tract infections.

17. Dinstinguish between the following two concepts:-

Colonisation (carriage of micro-organisms).

Infection.

18. State the differences between gram negative and gram positive bacteria.

19. i. The human Immunodeficiency virus [HIV] has been reported to be infectious in:-

| | Yes | No | Don't know |
|---|---|---|---|
| Saliva | | | |
| Faeces | | | |
| Breastmilk | | | |
| Vaginal secretions | | | |
| Blood | | | |

ii. The hepatitis B virus has been reported to be infectious in :-

| | Yes | No | Don't know |
|---|---|---|---|
| Saliva | | | |
| Faeces | | | |
| Breastmilk | | | |
| Vaginal secretions | | | |
| Blood | | | |

20. Please place a tick against the correct precautions which should be taken for a specific procedure on the table below:-

| | Clean gloves | Sterile gloves | Hand- washing | | Neither gloves nor hand-wash | Don't know |
|---|---|---|---|---|---|---|
| | | | before | after | | |
| 1. Emptying urine drainage bags. | | | | | | |
| 2. Handling soiled linen. | | | | | | |
| 3. Administering intravenous drugs. | | | | | | |
| 4. Endo-tracheal tube suction. | | | | | | |
| 5. Catheterizing a patient. | | | | | | |
| 6. Applying a dressing to an infected wound with forceps. | | | | | | |
| 7. Applying a dressing to an infected wound without forceps. | | | | | | |
| 8. Nursing a patient with burns. | | | | | | |
| 9. Washing a patient | | | | | | |
| 10. Nasogastric suction | | | | | | |
| 11. Performing mouth-care | | | | | | |
| 12. Handling chest drains. | | | | | | |
| 13. Withdrawing arterial blood samples. | | | | | | |

Thank for your help.

APPENDIX 2

## LIKERT SCALE

**Please tick whichever statement most applies to you.**

| | Strongly agree | Agree | Uncertain | Disagree | Strongly disagree |
|---|---|---|---|---|---|
| 1 Some infection control measures are too demanding to adhere to | | | | | |
| 2 Patients should have high standards of hygiene even if the nurses must spend more time on each procedure | | | | | |
| 3 Frequent hand-washing makes your hands sore | | | | | |
| 4 Strict adherence to control of infection procedures is a luxury which the busy nurse can seldom afford | | | | | |
| 5 Even if all nurses observed the correct procedures wherever necessary, cross infection would not be significantly reduced | | | | | |
| 6 Hospital-acquired infections only cause minor illnesses | | | | | |
| 7 Recapping needles protects the nurse from infection | | | | | |
| 8 There is always available time to wash hands efficiently | | | | | |
| 9 If a nurse suspects a colleague of an unhygienic practice h/she should explain the error to them | | | | | |
| 10 Little more can be done to further reduce cross-infection in hospital | | | | | |
| 11 Leaving needles uncapped puts staff at risk | | | | | |
| 12 To touch urine without the protection of gloves would be very unpleasant | | | | | |
| 13 When skin is intact, contact with blood is not a sufficiently serious health risk to warrant glove wearing | | | | | |
| 14 The risk of transmission of Hepatitis B from a patient with an undiagnosed infection on my ward/unit is minimal | | | | | |
| 15 It is unpleasant to accidentally touch the blood of a patient without wearing gloves | | | | | |
| 16 Glove wearing is uncomfortable and difficult to maintain | | | | | |
| 17 I would be very anxious about the risks of cross-infection if my patient suffered from HIV | | | | | |
| 18 Some contamination of the hands with blood is inevitable when caring for patients | | | | | |
| 19 It would be preferable to wear gloves whenever there is any contact with a patient's body fluids on this ward unit | | | | | |
| 20 Gloves are worn to protect the nurse rather than the patient | | | | | |
| 21 Rings should not be worn for nursing patients because they encourage infection risks | | | | | |
| 22 Washing hands between handling different pieces of equipment for the same patient (eg. nasogastric tube, IV) is not necessary as cross-infection cannot occur | | | | | |

APPENDIX 2

INTERVIEW SCHEDULE

Confidential

Study No.

Ward/Unit

Hospital

1. What percentage of hospital patients develop infection ?

2. Do you think that patients on your ward/unit are at particular risk of developing infection ?

    Yes

    No

    Don't know

    Probe

3. All nurses are at some risk of developing infections from patients. Do you think this risk is especially high on your ward/unit ?

    Yes

    No

    Don't know

    Probe

4. Do you consider awareness of the risk of infection to be high on your ward/unit ?

Yes

No

Don't know

Comments

5. i. I am going to show you scale and on it I would like you to indicate how serious you think hepatitis B is.

0 50 100

Not at all serious Very serious indeed

6. Have you been vaccinated against hepatitis B ?

Yes
No

7. i. Before qualifying did you receive any information about infection control ?

Yes
No
Can't remember
Specify

7. ii. Was this information adequate ?

Yes
No
Don't know
Comments

8. i. Since qualifying did you receive any information about infection control?

Yes
No
Don't know
Comments

8. ii. Was this adequate ?

Yes
No
Don't Know
Comments

iii. If no: - What else would be helpful ?

9. Are resources /equipment for preventing infection readily available on your unit ?

Gloves
Handwash agents
Sharps bins
Ward layout with sinks
Aprons

10. How often do you think you wash/cleanse hands per shift ?

11. i. Do you suffer from skin problems at all ? e.g. eczema, dermatitis ?

Yes
No
Sometimes

11. ii. Is this because of:

Washing hands a lot ?
Handwashing agents ?

12 Have you seen the infection control policy on this ward/Unit ?

Yes
No
Don't know

Ring worn:

Wrist-watch worn:

Apron worn:

1. Qualification - professional RGN SEN

ENB Certificate

2. Qualification - academic GCSE/ 0 levels

A' levels

Degree

Other

3. Years qualified.

4. Length of time working on this ward/unit.

5. Previous employment.

6. Age.

VISUAL ANALOGUE SCALES APPENDIX 2

A. Could you use the scale below to show whether you regard infection control to be given high priority on this ward:-

<——————————————————————————>
0 100%

Please give reasons

B. Could you indicate on the scale below how good this ward is as a learning environment for students?

<——————————————————————————>
0 100%

Please give reasons

C. Could you rate your level of job satisfaction on this scale below.

<——————————————————————————>
0 100%

Please give reasons

APPENDIX 2

FIELDNOTES CONT.

SUBJECT No.

APPENDIX 2

FIELDNOTES

SUBJECT No.

DEPENDENCY MEASURE APPENDIX 2

| Patient | Group | Score |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | | |
| 11 | | |
| 12 | | |
| 13 | | |
| 14 | | |
| 15 | | |
| 16 | | |
| 17 | | |
| 18 | | |
| 19 | | |
| 20 | | |
| 21 | | |
| 22 | | |
| 23 | | |
| 24 | | |
| 25 | | |
| 26 | | |
| 27 | | |
| 28 | | |

Total No. of Patients.

Group 1

Group 2

Group 3

Total ward score =

APPENDIX 2

WARD FACILITITES CHECKLIST

WARD/UNIT

1. No. Beds.

2. Total No. Staff: Qualified
Unqualified
Learners
Others

3. Sinks

| | Elbow taps |
|---|---|
| Nurse's station | |
| Treatment room | |
| Sluice | |
| Bedside | |

4. Hibiscrub

| | |
|---|---|
| Nurse's station | |
| Treatment Room | |
| Sluice | |
| Bedside | |

5. Hibisol

| | |
|---|---|
| Nurse's station | |
| Treatment Room | |
| Sluice | |
| Bedside | |

6. Wall dispenser Soap

| | |
|---|---|
| Nurses' station | |
| Treatment Room | |
| Sluice | |
| Bedside | |

7. Bar Soap

| | |
|---|---|
| Nurses' station | |
| Treatment Room | |
| Sluice | |
| Bedside | |

8. Gloves

| | Sterile | Not Sterile |
|---|---|---|
| Nurses' station | | |
| Treatment Room | | |
| Sluice | | |
| Bedside | | |

9. Sharps Boxes

| | |
|---|---|
| Nurses' station | |
| Treatment Room | |
| Sluice | |
| Bedside | |

10. Sharps Boxes full ? Yes No

11. Plastic aprons

| | |
|---|---|
| Nurses' station | |
| Treatment Room | |
| Sluice | |
| Bedside | |

12. Pedal bins available Yes No

13. Are infection control notices displayed ? Yes No

Comments

14. Are infection control policies/document available ? Yes No

15. Ward cleaning observed Yes No

Comments

# SCORING SYSTEM FOR THE THREE QUESTIONNAIRES CONCERNED WITH ELICITING NURSES' FACTUAL KNOWLEDGE OF INFECTION AND INFECTION PREVENTION.

**The Case Studies (knowledge of applied microbiology).**

**CASE STUDY 1**

Mr Charles Ives, admitted to your ward/unit last week, was unconscious but has since made steady progress, though still requiring intravenous fluids. He has an indwelling Foley catheter. He is an insulin-dependent diabetic, at present reliant on the nursing staff for his injections, though usually able to do this for himself.

1. What precautions if any would you take when handling Mr. Ives' blood and body fluids?

| | |
|---|---|
| *Wear gloves* | *- score 1.* |
| *Wash hands* | *- score 1.* |
| *Wear apron* | *- score 1.* |
| *Other* | *- score 1.* |
| *<u>Total score possible</u>* | *= 4* |

2a. Five days after admission it is discovered that Mr. Ives is a <u>carrier</u> for the <u>Hepatitis B antigen</u>. Explain what is meant by the words underlined.

*Ideal answer: A carrier is an individual who has been infected or colonised with a specific micro-organism and from whom this evidence may be recovered either by isolating the organism or evidence that the body has responded to it immunologically (ie antibody production), but who shows no signs or symptoms of infection (derived from Bennett & Brachman 1979).*

| | |
|---|---|
| *Displays full understanding of the concept of carriage* | *= score 4.* |
| *Limited understanding* | *= score 2.* |
| *<u>Total score possible</u>* | *= 4.* |

2b. Would the precautions you take with his blood and body fluids now differ from those you described above?
Please give reasons.
*There is evidence that today all patients' blood and body fluids should be regarded as infectious (see Gurevich 1988, Lynch et al 1990).*
*No = correct response - score 4*
*Yes = incorrect response - score 0*
*Total score possible* = 4.

3. To protect themselves from exposure to HIV, nurses should take the same precautions as they would for hepatitis B.
Please tick:
*Both infections are spread parenterally.*
*True* = - score 4.
*False*
*Not sure*
*Total score possible* = 4.

4. You have just given Mr. Ives his injection and you have sustained a needle-stick injury. What action would you take?
*According to hospital policy:*

| | |
|---|---|
| *Encourage bleeding* | = score 1. |
| *Wash under running water* | = score 1. |
| *Report to occupational health / A&E* | = score 1. |
| *Other relevant* | |
| *(eg blood will be taken, follow up)* | = score 1. |
| *Total score possible* | = 4. |

5. You have removed Mr Ives' intravenous infusion but the cannula ~~site is still oozing. Your skin becomes splashed with blood as you~~ apply a dressing. What action would you take?
Please give reasons.
*This question could not be included in the scoring system for Hospital A as this information was not available to staff owing of lack of agreement between members of the Infection Control Team.*

6. Remembering that Mr. Ives has an indwelling Foley catheter, use the scale below to estimate how much you think he is at risk of developing a urinary tract infection.

```
%                                        %
+---+---+---+---+---+---+---+---+---+---+
0                   50                  100
```

*According to research reviewed comprehensively by Clifford (1982), patients who have an indwelling urinary catheter for more than three days are at substantial risk of developing a urinary tract infection, especially the elderly and critically ill. From Case Study I it should be possible to deduce that Mr. Ives falls into this category. The figure chosen arbitrarily to represent "substantial" risk was 70%.*

*70% or more = score 4.*

*Total score possible = 4.*

7. Laboratory tests reveal that Mr. Ives' urine contains 'gentamicin resistant klebsiella. What is the meaning of this term?

*'Gentamicin resistant' refers to the ability of the bacteria to survive despite the patient receiving chemotherapy with this drug. i.e. receiving the drug will not destroy the infection.*

*Correct response = score 4.*

*Total score possible = 4.*

# TOTAL SCORE FOR CASE STUDY I = 28

APPENDIX THREE

CASE STUDY TWO

Mr. Percy Grainger, a patient on your ward/unit is found to be carrying methicillin-resistant Staphyloccus aureus (MRSA) in his wound.

8. Why is MRSA considered such a problem in hospitals>

*MRSA is notorious for causing outbreaks of infection which are difficult to treat because of the resistance of the bacteria to commonly used antibiotics (Phillips 1991). It is able to cause severe infections, but so is any strain of Staphyloccus aureus irrespective of antibiotic resistance.*

*Full understanding* = 4.

*Limited understanding* = 2.

*Total score possible* = 4.

9. How is MRSA spread? Please tick:

*Mostly by air*

*Mostly by contact* = *score 4 (Cafferkey et al 1985)*

*Mostly by insect vectors*

*Total score possible* = 4.

10. The following list consists of a number of nursing actions which may be taken to prevent spread of MRSA from patients who are infected/colonised to others in the same ward/unit. Please indicate on the list below those which you consider:-

A - Very useful ]
]
B - Moderately useful ] in preventing spread of infection.
]
C - Pointless ]

a) Wearing gloves when attending to Mr. Grainger.

A B C *Score = 4*

*MRSA is spread predominantly on the hands and good hand hygiene does much to reduce transmission (Cafferkey et al 1985).*

*According to the infection control policy in Hospital A, gloves should always be worn when attending such patients.*

b) Washing hands

A B C *Score = 4*

*Rationale as for 10a.*

c) Double-bagging Mr. Grainger's linen.

A B C *Score = 4*

*There is no evidence that double bagging is effective in reducing infection risks providing that spillage will not occur. (Maki et al 1986). In Hospital A double bagging was no longer part of the infection control policy.*

d) Putting Mr. Grainger in a single room with the door open.

A B C *Score = 4*

2 4

*As MRSA is spread mainly via contact, keeping the door shut is not a logical precaution: some authors regard confining infected patients to single rooms as valuable mainly because it warns staff to take precautions such as hand decontamination rather than because physical confinement prevents transmission (see Bagshawe et al 1978). However, this view was first expressed before the emergence of MRSA and the infection control policy in Hospital A stipulated that the door should be kept closed if possible.*

*Therefore score = 2 for A*

e) Putting Mr. Grainger in a single room with the door shut.

A B C *Score = 4*

2 4

*Rationale as for question 10d.*

f) Bathing Mr. Grainger daily in chlorhexidine (hibiscrub).

A B C *Score = 4*

*Evidence that pre-operative bathing or showering with chlorhexidine helps prevent post-operative wound infection is mixed (Byrne & Napier 1990), probably because different authors have used different experimental approaches. The infection control policy in Hospital A suggested that chlorhexidine baths might be valuable in 'certain cases' and advised consultation with the infection control team. There is nothing in the case study to suggest that Mr. Grainger is a surgical patient.*

g) Wearing a mask.

A B C *Score = 4*

*The efficiency of masks is difficult to evaluate (Masdsen & Mardsen 1967, Davies 1991). They are not recommended for routine use outside theatre (Ayliffe, Collins & Taylor 1990). The infection control policy in Hospital A recommended the use of masks for patients with MRSA only when "high risk" procedures were being performed (e.g. endotracheal suction).*

h) Wearing a cotton gown.

A B C *Score = 4*

*In recent years the literature concerning the use of protective clothing has focused heavily on what is most appropriate in theatre, especially when high risk orthopaedic surgery is performed and in specialist high risk units such as burns units (Hambraeuss 1973). Although contamination of cotton gowns and plastic aprons by Staphyloccus aureus is know to occur on nurses' uniforms, contamination does not increase with continued use of up to eleven days and is reduced when plastic aprons rather than gowns are worn (Babb et al 1983).*

*According to empirical research findings gowns offer no special protection, even in recognised high risk areas (Haque & Chagla 1989), while a comprehensive review by McIntosh (1982) concludes that requirements for protective clothing probably vary according to circumstance and that in general wards plastic aprons suffice.*

i) Wearing a plastic disposable apron.

A B C *Score = 4*

*Rationale as for 10h. The infection control policy for Hospital A advocated the use of plastic aprons for patients with MRSA.*

j) Wearing overshoes.

A B <u>C</u> *Score = 4*

*Overshoes are not recommended for use outside theatre (Ayliffe, Collins and Taylor 1990). Bacteria may be transferred to the hands when removing overshoes (Carter 1990). The infection control policy in Hospital A did not advocate use of overshoes outside theatre.*

k) Wearing a covering over your hair

A B <u>C</u> *Score = 4*

*There is little evidence that covering the hair prevents transmission of infection (Ayliffe, Collins & Taylor 1990). Protection by covering hair was not advocated in the infection control policy in Hospital A.*

l) Providing Mr. Grainger with disposable crockery and cutler.

A B <u>C</u> *Score = 4*

*There is no evidence that this is a useful precaution, a view shared by the Infection Control Policy in Hospital A.*

m) Allowing only one nurse per shift to attend to Mr. Grainger.

<u>A</u> B C *Score = 4*

*Given that MRSA is spread mainly by the contact route and that the hands provide the most common route of bacterial transmission in hospital (Albert & Condie 1981, Casewell & Phillips 1977) it is logical that this arrangement would effectively reduce infection risks if it was possible.*

*Total score for question 10 = 53.*

11. i. Routine swabs are taken from members of staff. You are told that you have become a nasal carrier of MRSA. Please indicate on the scale below your degree of concern:

%                                                                 %

+----+----+----+----+----+----+----+----+----+----+

0                               50                               100

Not at all concerned                                              Extremely concerned

ii. What would worry you (if anything) about carrying MRSA?

*French (1987) & Tuffnell (1988) report that fear of infection from MRSA patients constitutes a significant fear among New Zealand nurses. This question was included to provide data for comparison in U.K. hospitals. It is a question of opinion rather than factual knowledge, not contributing to the scoring system but included here as it seemed most appropriate following other questions concerning MRSA.*

*TOTAL SCORE POSSIBLE FOR CASE STUDY 2 = 60*

**The Principles of Microbiology (Theoretical Knowledge)**

12. State four micro-organisms specifically responsible for causing infection in hospital.

    *Score of 1 for any of the following:*

    *Klebsiella*

    *Pseudomonas*

    *E-coli*

    *Proteus*

    *Staph. aureus*

    *<u>Total score possible</u> = 4*

13a. List the main ways micro-organisms are spread in hospital.

    *Score 1 for any of the following:*

    *Contact = 2*

    *Fomites = 1*

    *Parenteral = 1*

    *N.B. "poor handwashing" score only if contact route is not mentioned.*

    *<u>Total score possible</u> = 4.*

13b. Place (x) against the mode of spread on your list for 13a which you consider the most important means of spread.

    *Contact = 4*

    *<u>Total score possible</u> = 4*

14. List the main ways through which micro-organisms gain access to the internal tissues.

    *Invasive procedures = 4*

    *(e.g. ventilation, catheterisation)*

    *<u>Total score possible</u> = 4*

15. Which types of patient do you think are at particular risk of developing infection? Please give reasons.

    *Very old and very young* = 1

    *Immunosuppressed, very sick* = 1

    *Invasive procedures* = 1

    *Mention specific predisposing illness e.g. diabetes mellitus*

    *<u>Total score possible</u> = 4*

16. Please rank the following in the order in which you consider they most commonly occur in hospital:

    *Surgical wound infections* = 2nd

    *Chest infections* = 3rd

    *Urinary tract infections* = 1st (Meers et al 1981)

    *Correct ranking* = 4

    *<u>Total score</u> = 4*

17. Distinguish between the following two concepts:

    *Colonisation (carriage of micro-organisms)*

    *Infection*

    *Ideal response adapted from Bennett & Brachman (1979): colonisation is the presence of organisms without evidence that the body has shown immunological reaction, while infection is indicated by immunological reaction and the overt signs and symptoms of disease.*

    *Good understanding of concept* = 4

    *Limited understanding* = 2

    *<u>Total possible score</u>* = 4

18. State the differences between Gram negative and Gram positive bacteria.

*Ideal response: These two groups of bacteria respond differently to laboratory staining procedures invaluable in classification, but they represent genuine physiological differences useful in planning infection control policies e.g. the two groups are sensitive to different antibiotics and withstand different degrees of desiccation.*

| | |
|---|---|
| *Good understand of concept* | *= score 4* |
| *Limited understanding* | *= score 2* |

19i. The Human Immunodeficieny Virus (HIV) has been reported to be infectious in:

| | Yes | No | Don't know |
|---|---|---|---|
| Saliva | | ✓ | |
| Faeces | | ✓ | |
| Breastmilk | ✓ | | |
| Vaginal secretions | ✓ | | |
| Blood | ✓ | | |

*Total Score = 20*

19.ii The hepatitis B virus has been reported to be infectious in:

| | Yes | No | Don't know |
|---|---|---|---|
| Saliva | | ✓ | |
| Faeces | | ✓ | |
| Breastmilk | | ✓ | |
| Vaginal secretions | ✓ | | |
| Blood | ✓ | | |

*Total Score = 20*

*Total score possible for Principles of Microbiology Questionnaire = 72.*

## APPENDIX THREE

**Knowledge of Hand Hygiene Precautions following specific procedures.**

20. Please place a tick against the correct precautions which should be taken for a specific procedure on the table below:

| | | | Hand-washing | | | |
|---|---|---|---|---|---|---|
| | Clean Gloves | Sterile gloves | Before | after | Neither gloves nor hand-wash | Don't know |
| 1.Emptying Urine drainage bags. | ✓ | | ✓ | ✓ | | |
| 2.Handling soiled linen. | ✓ | | | ✓ | | |
| 3.Administering intravenous drugs. | | | ✓ | ✓ | | |
| 4. Endo-tracheal tube suction. | | ✓ | ✓ | ✓ | | |
| 5. Catheterizing a patient. | | ✓ | ✓ | ✓ | | |
| 6. Applying a dressing to a wound with forceps. | | | ✓ | ✓ | | |
| 7. Applying a dressing to a wound without forceps. | | ✓ | ✓ | ✓ | | |
| 8. Nursing a patient with burns. | | ✓ | ✓ | ✓ | | |
| 9. Washing a patient. | | | ✓ | ✓ | | |
| 10. Nasogastric suction. | | | ✓ | ✓ | | |
| 11. Performing mouth-care. | | | ✓ | ✓ | | |
| 12. Handling chest drains. | | ✓ | ✓ | ✓ | | |
| 13. Withdrawing arterial blood samples. | ✓ | | ✓ | ✓ | | |

*(Adapted from policy in Hospital A)*

*Total Score = 4 for each correct response (i.e. each correct title).*

APPENDIX 4: DATA FROM PRELIMINARY ANALYSIS: an example

Subject 1

Mean Values for all scores are shown

Workload = 41 patient contacts

Total number of decontaminations = 11

Number of handwashes =9

Number of handrubs =2

Frequency/Rigor Score =11

Liberal Appropriateness Score (from raw data) should be 21

Actual Liberal Appropriateness Score =6

Agent Score =11.5

Handwashing Duration Score =9.4

Handwashing Drying Score = 10.5

Handwashing Surfaces Score=8.5

Handwashing Disposal Score = 12

Handrub Duration Score = 7

Handrub Surfaces Score =8

Total Number of occasions gloves were needed = 6

Number of occasions gloves were worn = 3

Glovewearing Score = 6

Inappropriate glovewearing =3

Number of ocassions sharps were used =1

Sharps Handling Score = 12

Sharps Disposal Score = 12

## The Raw Data

## Interview

Question 1 What percentage of hospital patients develop infection?

Number of Nurses Giving Realistic Estimate

| | | WARD | UNIT | | | |
|---|---|---|---|---|---|---|
| | | N* | N | % | | |
| ITU | 1 | 12 | 12 | 40 | HOSPITAL A | |
| | 2 | 4 | | | N | % |
| SURGICAL | 3 | 7 | 15 | 50 | 38 | 43.68 |
| | 4 | 4 | | | | |
| | 5 | 6 | | | | |
| MEDICAL | 6 | 5 | 11 | 40.74 | | |
| | 7 | 0 | | | | |
| ITU | 8 | 9 | 9 | 30 | HOSPITAL B | |
| | 9 | 5 | | | N | % |
| SURGICAL | 10 | 6 | 16 | 53.33 | 36 | 41.86 |
| | 11 | 5 | | | | |
| | 12 | 7 | | | BOTH HOSPITALS | |
| MEDICAL | 13 | 2 | 11 | 42.3 | N | % |
| | 14 | 2 | | | 74 | 42.77 |

* % not calculated when numbers are ten or less

Question 2 Do you think patients on your ward/unit are particularly at risk of developing infection

Number of nurses responding positively (patients are at risk)

| | | WARD | UNIT | | | |
|---|---|---|---|---|---|---|
| | | N | N | % | | |
| ITU | 1 | 26 | 26 | 86.66 | HOSPITAL A | |
| | 2 | 8 | | | N | % |
| SURGICAL | 3 | 7 | 24 | 80 | 71 | 81.61 |
| | 4 | 9 | | | | |
| | 5 | 7 | | | | |
| MEDICAL | 6 | 8 | 21 | 77.77 | | |
| | 7 | 6 | | | | |
| ITU | 8 | 28 | 28 | 93.33 | HOSPITAL B | |
| | 9 | 9 | | | N | % |
| SURGICAL | 10 | 5 | 19 | 63.33 | 58 | 67.44 |
| | 11 | 5 | | | | |
| | 12 | 7 | | | BOTH HOSPITALS | |
| MEDICAL | 13 | 2 | 11 | 42.31 | N | % |
| | 14 | 2 | | | 129 | 74.56 |

Question 3 All nuress are at some risk of developing infection from patients. Do you think you are at particular risk on your ward /unit?

Number of nurses responding positively

| | | WARD | UNIT | | | |
|---|---|---|---|---|---|---|
| | | N | N | % | | |
| ITU | 1 | 20 | 20 | 66.66 | HOSPITAL A | |
| | 2 | 2 | | | N | % |
| SURGICAL | 3 | 3 | 7 | 23.33 | 39 | 44.83 |
| | 4 | 2 | | | | |
| | 5 | 5 | | | | |
| MEDICAL | 6 | 4 | 12 | 44.45 | | |
| | 7 | 2 | | | | |
| ITU | 8 | 18 | 18 | 60 | HOSPITAL B | |
| | 9 | 4 | | | N | % |
| SURGICAL | 10 | 1 | 6 | 20 | 28 | 32.56 |
| | 11 | 1 | | | | |
| | 12 | 1 | | | BOTH HOSPITALS | |
| MEDICAL | 13 | 1 | 4 | 15.37 | N | % |
| | 14 | 2 | | | 67 | 38.72 |

Question 5 Nurses' perceptions of Hepatitis B as a serious medical condition

Number of nurses very concerned about Hepatitis B
(rating on VAS over 80%)

| | | WARD | UNIT | | | |
|---|---|---|---|---|---|---|
| | | N | N | % | | |
| ITU | 1 | 15 | 15 | 50 | HOSPITAL A | |
| | 2 | 4 | | | N | % |
| SURGICAL | 3 | 3 | 11 | 39.67 | 40 | 45.98 |
| | 4 | 4 | | | | |
| | 5 | 4 | | | | |
| MEDICAL | 6 | 5 | 14 | 51.86 | | |
| | 7 | 5 | | | | |
| ITU | 8 | 17 | 17 | 56.67 | HOSPITAL B | |
| | 9 | 6 | | | N | % |
| SURGICAL | 10 | 2 | 11 | 39.67 | 40 | 46.52 |
| | 11 | 3 | | | | |
| | 12 | 7 | | | BOTH HOSPITALS | |
| MEDICAL | 13 | 3 | 12 | 45.16 | N | % |
| | 14 | 2 | | | 80 | 46.25 |

Question 6 Number of nurses immunised against hepatitis B

| | | WARD | UNIT | | | |
|---|---|---|---|---|---|---|
| | | N | N | % | | |
| ITU | 1 | 25 | 25 | 83.33 | HOSPITAL A | |
| | 2 | 6 | | | N | % |
| SURGICAL | 3 | 7 | 19 | 63.33 | 63 | 72.42 |
| | 4 | 6 | | | | |
| | 5 | 7 | | | | |
| MEDICAL | 6 | 8 | 19 | 70.37 | | |
| | 7 | 4 | | | | |
| ITU | 8 | 25 | 25 | 83.33 | HOSPITAL B | |
| | 9 | 9 | | | N | % |
| SURGICAL | 10 | 5 | 21 | 70 | 63 | 73.25 |
| | 11 | 7 | | | | |
| | 12 | 6 | | | BOTH HOSPITALS | |
| MEDICAL | 13 | 5 | 17 | 65.39 | N | % |
| | 14 | 6 | | | 126 | 72.83 |

Question 7a Number of nurses rcalling pre-registration teaching on infection control

| | | WARD | UNIT | | | |
|---|---|---|---|---|---|---|
| | | N | N | % | | |
| ITU | 1 | 16 | 16 | 53.33 | HOSPITAL A | |
| | 2 | 8 | | | N | % |
| SURGICAL | 3 | 8 | 24 | 80 | 63 | 72.42 |
| | 4 | 8 | | | | |
| | 5 | 9 | | | | |
| MEDICAL | 6 | 8 | 23 | 85.18 | | |
| | 7 | 6 | | | | |
| ITU | 8 | 23 | 23 | 76.66 | HOSPITAL B | |
| | 9 | 7 | | | N | % |
| SURGICAL | 10 | 10 | 17 | 86.66 | 66 | 76.75 |
| | 11 | 9 | | | | |
| | 12 | 6 | | | BOTH HOSPITALS | |
| MEDICAL | 13 | 5 | 4 | 65.38 | N | % |
| | 14 | 6 | | | 129 | 74.56 |

Question 8a Number of nurses recalling post-registration opportunities to learn about infection control

| | | WARD | UNIT | | | |
|---|---|---|---|---|---|---|
| | | N | N | % | | |
| ITU | 1 | 25 | 25 | 83.33 | HOSPITAL A | |
| | 2 | 5 | | | N | % |
| SURGICAL | 3 | 4 | 15 | 50 | 53 | 60.92 |
| | 4 | 6 | | | | |
| | 5 | 2 | | | | |
| MEDICAL | 6 | 5 | 13 | 48.15 | | |
| | 7 | 6 | | | | |
| ITU | 8 | 23 | 23 | 76.66 | HOSPITAL B | |
| | 9 | 7 | | | N | % |
| SURGICAL | 10 | 6 | 19 | 63.33 | 55 | 63.96 |
| | 11 | 6 | | | | |
| | 12 | 3 | | | BOTH HOSPITALS | |
| MEDICAL | 13 | 5 | 13 | 50 | N | % |
| | 14 | 5 | | | 108 | 62.43 |

Question 8b Number of nurses satisfied with postbasic opportunities to continue learning about infection control

| | | WARD | UNIT | | | |
|---|---|---|---|---|---|---|
| | | N | N | % | | |
| ITU | 1 | 14 | 14 | 46.66 | HOSPITAL A | |
| | 2 | 2 | | | N | % |
| SURGICAL | 3 | 5 | 12 | 40 | 31 | 35.63 |
| | 4 | 5 | | | | |
| | 5 | 1 | | | | |
| MEDICAL | 6 | 0 | 5 | 18.5 | | |
| | 7 | 4 | | | | |
| ITU | 8 | 10 | 10 | 33.33 | HOSPITAL B | |
| | 9 | 3 | | | N | % |
| SURGICAL | 10 | 2 | 8 | 26.66 | 21 | 24.41 |
| | 11 | 3 | | | | |
| | 12 | 1 | | | BOTH HOSPITALS | |
| MEDICAL | 13 | 1 | 3 | 11.54 | N | % |
| | 14 | 1 | | | 52 | 30.06 |

Question 9a Number of nurses not completely satisfied with supplies of gloves

| | | WARD | UNIT | | | |
|---|---|---|---|---|---|---|
| | | N | N | % | | |
| ITU | 1 | 11 | 11 | 36.67 | HOSPITAL A | |
| | 2 | 2 | | | N | % |
| SURGICAL | 3 | 5 | 10 | 33.34 | 42 | 48.27 |
| | 4 | 3 | | | | |
| | 5 | 7 | | | | |
| MEDICAL | 6 | 10 | 21 | 77.77 | | |
| | 7 | 4 | | | | |
| ITU | 8 | 6 | 6 | 20 | HOSPITAL B | |
| | 9 | 0 | | | N | % |
| SURGICAL | 10 | 1 | 2 | 6.67 | 14 | 16.27 |
| | 11 | 1 | | | | |
| | 12 | 3 | | | BOTH HOSPITALS | |
| MEDICAL | 13 | 1 | 6 | 23.08 | N | % |
| | 14 | 2 | | | 56 | 32.37 |

Question 9b Number of nurses not satisfied with supplies of hand decontaminating agents

| | | WARD | UNIT | | | |
|---|---|---|---|---|---|---|
| | | N | N | % | | |
| ITU | 1 | 16 | 16 | 53.34 | HOSPITAL A | |
| | 2 | 1 | | | N | % |
| SURGICAL | 3 | 8 | 10 | 33.4 | 39 | 44.83 |
| | 4 | 1 | | | | |
| | 5 | 7 | | | | |
| MEDICAL | 6 | 5 | 13 | 48.15 | | |
| | 7 | 1 | | | | |
| ITU | 8 | 0 | 0 | 0 | HOSPITAL B | |
| | 9 | 0 | | | N | % |
| SURGICAL | 10 | 1 | 2 | 6.67 | 3 | 3.48 |
| | 11 | 1 | | | | |
| | 12 | 0 | | | BOTH HOSPITALS | |
| MEDICAL | 13 | 1 | 1 | 3.84 | N | % |
| | 14 | 0 | | | 42 | 24.28 |

Question 9c Number of nurses not satisfied with supplies of sharps boxes

| | | WARD | UNIT | | | |
|---|---|---|---|---|---|---|
| | | N | N | % | | |
| ITU | 1 | 1 | 1 | 3.33 | HOSPITAL A | |
| | 2 | 2 | | | N | % |
| SURGICAL | 3 | 1 | 4 | 13.34 | 10 | 11.5 |
| | 4 | 1 | | | | |
| | 5 | 2 | | | | |
| MEDICAL | 6 | 3 | 5 | 18.51 | | |
| | 7 | 0 | | | | |
| ITU | 8 | 1 | 1 | 3.33 | HOSPITAL B | |
| | 9 | 1 | | | N | % |
| SURGICAL | 10 | 3 | 6 | 20 | 12 | 13.96 |
| | 11 | 2 | | | | |
| | 12 | 4 | | | BOTH HOSPITALS | |
| MEDICAL | 13 | 0 | 5 | 19.23 | N | % |
| | 14 | 1 | | | 22 | 12.72 |

Question 9d Number of nurses not completely satisfied with provision of sinks

| | | WARD | UNIT | | |
|---|---|---|---|---|---|
| | | N | N | % | |
| ITU | 1 | 12 | 12 | 40 | HOSPITAL A |
| | 2 | 3 | | | N % |
| SURGICAL | 3 | 3 | 9 | 30 | 28 32.19 |
| | 4 | 3 | | | |
| | 5 | 1 | | | |
| MEDICAL | 6 | 3 | 7 | 25.92 | |
| | 7 | 3 | | | |
| ITU | 8 | 12 | 12 | 40 | HOSPITAL B |
| | 9 | 0 | | | N % |
| SURGICAL | 10 | 0 | 1 | 3.33 | 15 17.44 |
| | 11 | 1 | | | |
| | 12 | 2 | | | BOTH HOSPITALS |
| MEDICAL | 13 | 0 | 2 | 7.69 | N % |
| | 14 | 0 | | | 43 24.86 |

Question 9e Number of nurses not satisfied with supply of aprons

| | | WARD | UNIT | | | |
|---|---|---|---|---|---|---|
| | | N | N | % | | |
| ITU | 1 | 3 | 3 | 10 | HOSPITAL A | |
| | 2 | 3 | | | N | % |
| SURGICAL | 3 | 2 | 5 | 16.67 | 12 | 13.8 |
| | 4 | 0 | | | | |
| | 5 | 2 | | | | |
| MEDICAL | 6 | 2 | 4 | 14.01 | | |
| | 7 | 0 | | | | |
| ITU | 8 | 3 | 3 | 10 | HOSPITAL B | |
| | 9 | 1 | | | N | % |
| SURGICAL | 10 | 6 | 10 | 33.34 | 19 | 22.10 |
| | 11 | 3 | | | | |
| | 12 | 1 | | | BOTH HOSPITALS | |
| MEDICAL | 13 | 2 | 6 | 23.07 | N | % |
| | 14 | 3 | | | 31 | 17.91 |

## Q10 Nurses' estimates of their own hand decontamination frequency

| | | | | | UNIT | | | HOSPITAL | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ward | Over | Under | Correct | Over | Under | Correct | Over | | Under | | Correct | |
| ITU | 1 | 3 | 3 | 4 | 3 | 3 | 4 | A | % | | % | | % |
| | 2 | 3 | 2 | 4 | | | | | | | | | |
| SURGICAL | 3 | 1 | 2 | 4 | 5 | 7 | 11 | | | | | | |
| | 4 | 1 | 3 | 3 | | | | 13 | 22.41 | 17 | 29.31 | 20 | 34.48 |
| | 5 | 1 | 1 | 0 | | | | | | | | | |
| MEDICAL | 6 | 4 | 4 | 0 | 5 | 7 | 5 | N - 58 | | | | | |
| | 7 | 0 | 2 | 5 | | | | | | | | | |
| ITU | 8 | 2 | 5 | 5 | 2 | 5 | 5 | B | | | | | |
| | 9 | 0 | 2 | 7 | | | | | | | | | |
| SURGICAL | 10 | 1 | 2 | 7 | 6 | 6 | 17 | | | | | | |
| | 11 | 5 | 2 | 3 | | | | | | | | | |
| | 12 | 0 | 2 | 2 | | | | 12 | 26.08 | 16 | 34.78 | 26 | 56.52 |
| MEDICAL | 13 | 2 | 0 | 0 | 4 | 5 | 4 | | | | | | |
| | 14 | 2 | 3 | 2 | | | | N = 46 | | | | | |
| | | | | | | | | Both Hospitals | | | | | |
| | | | | | | | | 25 | 24.03 | 33 | 31.73 | 46 | 44.23 |

N = 104

Question 11 Number of nurses reporting sore, dry hands

| | | WARD | UNIT | | | |
|---|---|---|---|---|---|---|
| | | N | N | % | | |
| ITU | 1 | 20 | 20 | 66.66 | HOSPITAL A | |
| | 2 | 5 | | | N | % |
| SURGICAL | 3 | 7 | 15 | 66.66 | 50 | 57.47 |
| | 4 | 7 | | | | |
| | 5 | 5 | | | | |
| MEDICAL | 6 | 5 | 15 | 55.55 | | |
| | 7 | 5 | | | | |
| ITU | 8 | 27 | 27 | 90 | HOSPITAL B | |
| | 9 | 9 | | | N | % |
| SURGICAL | 10 | 2 | 19 | 63.33 | 72 | 83.73 |
| | 11 | 8 | | | | |
| | 12 | 10 | | | BOTH HOSPITALS | |
| MEDICAL | 13 | 8 | 26 | 100 | N | % |
| | 14 | 8 | | | 122 | 70.52 |

Question 12 Number of nurses who reported seeing the infection control policy

| | | WARD | UNIT | | | |
|---|---|---|---|---|---|---|
| | | N | N | % | | |
| ITU | 1 | 18 | 18 | 60 | HOSPITAL A | |
| | 2 | 7 | | | N | % |
| SURGICAL | 3 | 4 | 20 | 66.66 | 59 | 67.82 |
| | 4 | 9 | | | | |
| | 5 | 8 | | | | |
| MEDICAL | 6 | 9 | 21 | 77.77 | | |
| | 7 | 4 | | | | |
| ITU | 8 | 14 | 14 | 46.66 | HOSPITAL B | |
| | 9 | 5 | | | N | % |
| SURGICAL | 10 | 3 | 10 | 33.34 | 33 | 38.58 |
| | 11 | 2 | | | | |
| | 12 | 2 | | | BOTH HOSPITALS | |
| MEDICAL | 13 | 5 | 9 | 34.62 | N | % |
| | 14 | 2 | | | 92 | 53.18 |

## Likert Scale

| Ward | Mean | Median | Range | SD |
|---|---|---|---|---|
| 1 | 81.75 | 82.5 | 70-100 | 7.58 |
| 2 | 78.3 | 79.5 | 63-95 | 9.94 |
| 3 | 74.44 | 75 | 64-82 | 6.71 |
| 4 | 77.5 | 79 | 69-82 | 4.45 |
| 5 | 82.88 | 81.5 | 75-91 | 6.15 |
| 6 | 82.2 | 82.5 | 64-100 | 10.52 |
| 7 | 76.25 | 76 | 68-83 | 4.49 |
| 8 | 84.3 | 85 | 68-100 | 7.2 |
| 9 | 81.8 | 82 | 74-88 | 4.8 |
| 10 | 77.38 | 77 | 69-83 | 4.83 |
| 11 | 85.57 | 84 | 81-95 | 4.69 |
| 12 | 82.33 | 78 | 74-95 | 11.15 |
| 13 | ------ | ------ | ------ | ------ |
| 14 | 84.4 | 82 | 78-93 | 6.73 |

| | Unit/Hospital A | | | | Unit/Hospital B | | | | Both Hospitals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Median | Range | SD | Mean | Median | Range | SD | Mean | Median | Range | SD |
| ITU | 81.75 | 82.5 | 70-100 | 7.54 | 84.3 | 85 | 68-100 | 7.2 | 82.9 | 83 | 68-100 | 7.42 |
| Surgical | 76.83 | 78 | 63-95 | 7.04 | 81.44 | 81 | 69-75 | 5.52 | 78.96 | 79.5 | 63-95 | 6.79 |
| Medical | 80.58 | 8.07 | 64-100 | 8.07 | 83.62 | 80.5 | 74-95 | 7.91 | 81.29 | 79.5 | 64-100 | 8.02 |
| All | 79.66 | 79 | 53-100 | 7.74 | 82.72 | 83 | 68-100 | 6.63 | 80.95 | 81 | 63-100 | 7.4 |

## The Knowledge Questionnaires

### Case Study 1 Blood and Body Fluid Precautions

| Ward | Mean | Median | Range | SD |
|---|---|---|---|---|
| 1 | 17.96 | 18 | 9-28 | 4.71 |
| 2 | 18.22 | 18 | 10-23 | 3.87 |
| 3 | 17.8 | 19 | 10-23 | 4.18 |
| 4 | 17.4 | 18 | 10-23 | 4.4 |
| 5 | 16.71 | 17 | 10-22 | 3.9 |
| 6 | 17.2 | 17.5 | 8-23 | 4.08 |
| 7 | 17.57 | 17 | 15-20 | 2.07 |
| 8 | 21.26 | 22 | 14-27 | 3.85 |
| 9 | 17.6 | 17.5 | 10-26 | 4.55 |
| 10 | 20.57 | 20 | 16-25 | 3.15 |
| 11 | 21.50 | 21.5 | 19-24 | 3.54 |
| 12 | 24 | 24 | 22-96 | 2 |
| 13 | ------ | ------ | ------ | ------ |
| 14 | 19.6 | 21 | 13-23 | 3.97 |

| | Unit/Hospital A | | | | Unit/Hospital B | | | | Both Hospitals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Median | Range | SD | Mean | Median | Range | SD | Mean | Median | Range | SD |
| ITU | 17.96 | 18 | 9-28 | 4.71 | 21.26 | 22 | 14-27 | 3.85 | 19.45 | 19 | 9-28 | 4 61 |
| Surgical | 17.67 | 18 | 10-23 | 4.05 | 19.1 | 20 | 10-26 | 4.13 | 18.25 | 19 | 10-26 | 4.1 |
| Medical | 17.16 | 17 | 8-23 | 3.42 | 21.25 | 22 | 13-26 | 3.92 | 18.18 | 18.5 | 8-26 | 3.9 |
| All | 17.62 | 18 | 8-28 | 4.09 | 20.44 | 21 | 10-27 | | 18.7 | 19 | 8-28 | 4.28 |

## Case Study 2 Contact Precautions

| Ward | Mean | Median | Range | SD |
|---|---|---|---|---|
| 1 | 25.57 | 25 | 10-38 | 8.04 |
| 2 | 26.89 | 26 | 18-36 | 6.86 |
| 3 | 24.4 | 25 | 10-34 | 7.49 |
| 4 | 21.6 | 21 | 8-32 | 7.08 |
| 5 | 21.14 | 24 | 4-30 | 9.08 |
| 6 | 23 | 24 | 8-44 | 11.05 |
| 7 | 18.29 | 16 | 8-28 | 6.97 |
| 8 | 23.91 | 26 | 10-36 | 7.64 |
| 9 | 26 | 28 | 10-36 | 7.12 |
| 10 | 27.14 | 28 | 20-32 | 4.14 |
| 11 | 18 | 18 | 10-26 | 11.31 |
| 12 | 24.67 | 24 | 16-34 | 9.02 |
| 13 | ------ | ------ | ------ | ------ |
| 14 | 33.2 | 34 | 28-36 | 3.03 |

| | Unit/Hospital A | | | | Unit/Hospital B | | | | Both Hospitals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Median | Range | SD | Mean | Median | Range | SD | Mean | Median | Range | SD |
| ITU | 25.57 | 25 | 10-38 | 8.04 | 23.91 | 26 | 10-36 | 7.14 | 24.63 | 26 | 10-38 | 7.83 |
| Surgical | 24.07 | 24 | 8-36 | 7.13 | 25.58 | 28 | 8-36 | 6.75 | 24.55 | 26 | 8-36 | 6.94 |
| Medical | 21.08 | 21 | 4-44 | 9.27 | 30 | 34 | 16-36 | 6.93 | 23.31 | 24 | 4-44 | 9.48 |
| All | 23.5 | 24 | 4-444 | 8.23 | 25.52 | 27 | 10-36 | 7.37 | 24.27 | 25 | 4-44 | 7.93 |

## Principles of Microbiology

| Ward | Mean | Median | Range | SD |
|---|---|---|---|---|
| 1 | 31.43 | 33 | 15-47 | 9.65 |
| 2 | 28.78 | 30 | 16-38 | 7.26 |
| 3 | 31.7 | 27.5 | 23-43 | 7.85 |
| 4 | 32.2 | 34.5 | 14-42 | 8.48 |
| 5 | 35.43 | 41 | 12-46 | 12.25 |
| 6 | 36.4 | 40 | 17-48 | 10.8 |
| 7 | 30.14 | 33 | 19-4 | 7.86 |
| 8 | 36.59 | 38 | 24-48 | 6.81 |
| 9 | 34 | 32 | 25-46 | 6.6 |
| 10 | 37.14 | 37 | 28-47 | 7.24 |
| 11 | 37.5 | 37.5 | 32-43 | 7.78 |
| 12 | 38 | 40 | 34-40 | 3.46 |
| 13 | ------ | ------ | ------ | ------ |
| 14 | 41.2 | 41 | 30-55 | 9.36 |

| | Unit/Hospital A | | | | Unit/Hospital B | | | | Both Hospitals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Median | Range | SD | Mean | Median | Range | SD | Mean | Median | Range | SD |
| ITU | 31.43 | 33 | 15-47 | 8.1 | 36.59 | 38 | 24-48 | 6.81 | 33.7 | 35 | 15-48 | 8.83 |
| Surgical | 31.18 | 31 | 14-43 | 8.04 | 35.53 | 34 | 25-47 | 6.74 | 32.94 | 33 | 14-47 | 7.63 |
| Medical | 34.29 | 34.5 | 12-48 | 7 | 40 | 40 | 30-55 | 7.5 | 35.72 | 37.5 | 12-55 | 9.97 |
| All | 32.2 | 33 | 12-48 | 9.27 | 36.73 | 37 | 34-55 | 6.91 | 33.92 | 35 | 14-47 | 8.72 |

## Knowledge of Hand Protection for Specific Nursing Procedure (KHP)

| Ward | Mean | Median | Range | SD |
|---|---|---|---|---|
| 1 | 29 | 31 | 8-46 | 11.58 |
| 2 | 36 | 38 | 26-42 | 5.95 |
| 3 | 35.11 | 38 | 20-44 | 7.15 |
| 4 | 30.6 | 34 | 12-40 | 10.24 |
| 5 | 38.57 | 40 | 28-42 | 4.86 |
| 6 | 37.4 | 37 | 28-48 | 5.89 |
| 7 | 29.43 | 38 | 0-40 | 16.44 |
| 8 | 31.36 | 35 | 10-48 | 11.44 |
| 9 | 33.4 | 33 | 22-44 | 6.93 |
| 10 | 30.57 | 32 | 6-44 | 12.74 |
| 11 | 22 | 22 | 4-40 | 25.5 |
| 12 | 35.33 | 36 | 30-40 | 5.03 |
| 13 | ----- | ----- | ----- | ----- |
| 14 | 26 | 26 | 2-42 | 16.97 |

| | Unit/Hospital A | | | | Unit/Hospital B | | | | Both Hospitals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Median | Range | SD | Mean | Median | Range | SD | Mean | Median | Range | SD |
| ITU | 29 | 31 | 8-46 | 11.58 | 31.36 | 35 | 10-48 | 11.44 | 30.04 | 33 | 8-48 | 11.46 |
| Surgical | 33.7 | 38 | 12-44 | 8.22 | 31.16 | 32 | 4-44 | 11.24 | 32.65 | 34 | 4-44 | 9.55 |
| Medical | 35.42 | 38 | 0-48 | 10.29 | 29.5 | 33 | 2-42 | 13.97 | 33.94 | 38 | 0-48 | 11.38 |
| All | 32.56 | 36 | 0-48 | 10.38 | 30.98 | 54 | 11.56 | 11.56 | 31.95 | 36 | 0-48 | 10.82 |

## Total Number of Clinical Contacts (Workload)

| Ward | Mean | Median | Range | SD |
|---|---|---|---|---|
| 1 | 30.03 | 28.5 | 3-54 | 13.54 |
| 2 | 15 | 13.5 | 2-32 | 9.01 |
| 3 | 27.3 | 24.5 | 7-49 | 12.69 |
| 4 | 25.1 | 24.5 | 6-40 | 10.84 |
| 5 | 17.33 | 15 | 4-35 | 10.19 |
| 6 | 24.6 | 27 | 5-40 | 12.36 |
| 7 | 26.6 | 26.5 | 17-44 | 9.04 |
| 8 | 25.57 | 23.57 | 11-47 | 8.44 |
| 9 | 29.1 | 27.5 | 17-41 | 8.01 |
| 10 | 29.8 | 32 | 15-50 | 10.37 |
| 11 | 18.2 | 19.5 | 9-26 | 5.25 |
| 12 | 15.2 | 14.5 | 8-31 | 6.18 |
| 13 | 15.13 | 14.5 | 7-27 | 6.49 |
| 14 | 19.25 | 18.5 | 14-29 | 4.71 |

| | Unit/Hospital A | | | | Unit/Hospital B | | | | Both Hospitals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Median | Range | SD | Mean | Median | Range | SD | Mean | Median | Range | [illegible] |
| ITU | 30.03 | 28.5 | 3-54 | 13.54 | 25.57 | 23.5 | 11-47 | 8.44 | 27.8 | 6.5 | 7-54 | [illegible] |
| Surgical | 22.47 | 23.5 | 2-49 | 11.89 | 25.7 | 24.5 | 9-50 | 9.54 | 24.08 | 23.5 | 3-50 | [illegible] |
| Medical | 22.78 | 22 | 4-44 | 11.08 | 16.42 | 15.5 | 7-31 | 5.95 | 19.66 | 17 | 4-44 | [illegible] |
| All | 25.17 | 24.91 | 3-54 | 12.61 | 22.84 | 22.43 | 7-50 | 9.15 | 24.01 | 23 | 3-54 | [illegible] |

## Frequency of Hand Decontamination (Rigor Score)

| Ward | Mean | Median | Range | SD | % |
|---|---|---|---|---|---|
| 1 | 5.6 | 5.5 | 1-13 | 2.73 | 22.92 |
| 2 | 4.7 | 4 | 0-12 | 3.3 | 29.34 |
| 3 | 6.3 | 6.5 | 2-12 | 3.47 | 24.18 |
| 4 | 8.4 | 7.5 | 1-21 | 5.8 | 33.47 |
| 5 | 4.83 | 5 | 0-8 | 2.64 | 25 |
| 6 | 5.8 | 5.5 | 0-13 | 3.88 | 23.58 |
| 7 | 10 | 10 | 5-15 | 3.63 | 37.56 |
| 8 | 9.16 | 7.5 | 5-21 | 4.45 | 35.86 |
| 9 | 6.9 | 8 | 4-17 | 3.96 | 23.72 |
| 10 | 8.1 | 7.5 | 4-16 | 4.43 | 27.19 |
| 11 | 6.64 | 7.5 | 1-12 | 3.47 | 35.17 |
| 12 | 5.5 | 5 | 2-17 | 3.24 | 36.19 |
| 13 | 4.87 | 4 | 1-11 | 2.8 | 30.17 |
| 14 | 4.12 | 4.5 | 1-12 | 2.35 | 21.43 |

| | Unit/Hospital A | | | | Unit/Hospital B | | | | Both Hospitals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Median | Range | SD % | Mean | Median | Range | SD % | Mean | Median | Range | SD % |
| ITU | 5.6 | 5.5 | 1-13 | 2.73 22.92 | 9.16 | 7.5 | 5-21 | 4.45 35.86 | 7.38 | 6 | 1-21 | 4.08 29.54 |
| S | 6.46 | 5.5 | 0-21 | 4.46 27.3 | 7.13 | 7.5 | 1-17 | 3.9 27.76 | 6.8 | 7 | 0-21 | 4.16 28.36 |
| M | 6.5 | 6.5 | 0-15 | 4.06 28.79 | 4.88 | 5 | 0-12 | 2.8 29.34 | 5.73 | 5 | 0-15 | 3.56 29.01 |
| All | 6.19 | 6 | 0-21 | 3.79 24.64 | 7.16 | 6.5 | 0-21 | 4.15 31.35 | 6.67 | 6 | 0-21 | 3.99 28.78 |

## LAS iess Score

| Ward | Mean | Median | Range | SD | % |
|---|---|---|---|---|---|
| 1 | 13.1 | 12 | 4-28 | 5.83 | 35.37 |
| 2 | 8.6 | 9 | 2-15 | 4.45 | 48.38 |
| 3 | 10.8 | 10 | 4-20 | 5.65 | 39.32 |
| 4 | 12.6 | 12 | 2-24 | 7.66 | 52.39 |
| 5 | 9.89 | 9 | 3-24 | 7.34 | 40.45 |
| 6 | 11.3 | 13.5 | 3-18 | 5.83 | 47.79 |
| 7 | 15.25 | 14.5 | 9.25 | 4.83 | 60.66 |
| 8 | 12.5 | 12 | 6-27 | 5.07 | 64.27 |
| 9 | 14.2 | 12.5 | 5-23 | 5.92 | 45.78 |
| 10 | 14.6 | 13 | 6.24 | 5.11 | 54.8 |
| 11 | 8 | 9 | 3-13 | 3.56 | 68.75 |
| 12 | 6.4 | 5 | 3-18 | 4.43 | 65.63 |
| 13 | 6.37 | 6.5 | 3-13 | 2.44 | 66.67 |
| 14 | 10.12 | 8.5 | 7-19 | 4.19 | 38.28 |

| | Unit/Hospital A | | | | Unit/Hospital B | | | | Both Hospitals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Median | Range | SD % | Mean | Median | Range | SD % | Mean | Median | Range | SD % |
| ITU | 13.1 | 12 | 4-28 | 5.83 35.37 | 12.5 | 12 | 6-27 | 5.07 64.27 | 12.8 | 12 | 4-28 | 5.42 49 48 |
| S | 10.67 | 10 | 2-24 | 6.09 55.36 | 12.26 | 11 | 3-24 | 5.92 54.35 | 11.46 | 11 | 1-24 | 6.01 52.24 |
| M | 12 | 14.5 | 3-25 | 6.29 50.62 | 7.53 | 7 | 3-19 | 4.09 54.6 | 9.81 | 8 | 3-25 | 5.73 52.12 |
| All | 11 92 | 11 | 2-28 | 6.07 42.15 | 10.91 | 10 | 3-24 | 5.54 58.36 | 11.42 | 10 | 2-28 | 5.82 49.85 |

## Handwashing Frequency

| Ward | Mean | Median | Range | SD |
|---|---|---|---|---|
| 1 | 4.73 | 5 | 1-12 | 2.59 |
| 2 | 2.7 | 2 | 0-12 | 1.82 |
| 3 | 6.1 | 6.5 | 0-10 | 3.28 |
| 4 | 5.2 | 6.5 | 1-8 | 2.82 |
| 5 | 4 | 4 | 0-8 | 2.59 |
| 6 | 5 | 4.5 | 0-10 | 3.23 |
| 7 | 6.37 | 6 | 5-10 | 2.26 |
| 8 | 5.1 | 3.5 | 0-9 | 2.81 |
| 9 | 5.9 | 5 | 1-10 | 3.35 |
| 10 | 4.9 | 5 | 2-12 | 3.1 |
| 11 | 4.5 | 5 | 1-7 | 2.01 |
| 12 | 5.1 | 5 | 1-10 | 2.51 |
| 13 | 4.37 | 3.5 | 2-9 | 2.5 |
| 14 | 3.75 | 4.5 | 0-6 | 1.98 |

| | Unit/Hospital A | | | | Unit/Hospital B | | | | Both Hospitals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Median | Range | SD | Mean | Median | Range | SD | Mean | Median | Range | SD |
| ITU | 4.73 | 5 | 1-12 | 2.59 | 5.1 | 3.5 | 0-9 | 2.81 | 4.8 | 4 | 0-12 | 2.68 |
| Surgical | 4.63 | 5 | 0-12 | 2.99 | 5.06 | 5 | 0-12 | 2.84 | 4.88 | 5 | 0-12 | 2.9 |
| Medical | 5.14 | 5 | 0-10 | 2.82 | 4.46 | 4.5 | 0-10 | 2.33 | 4.77 | 5 | 0-10 | 2.59 |
| All | 4.81 | 5 | 0-12 | 2.78 | 4.88 | 4.5 | 0-12 | 2.78 | 4.84 | 5 | 0-12 | 2.74 |

## Frequency of Handrub Use

| Ward | Mean | Median | Range | SD |
|---|---|---|---|---|
| 1 | 0.66 | 0 | 0-5 | 1.29 |
| 2 | 1.2 | 0 | 0-6 | 2.3 |
| 3 | 1.7 | 2 | 0-5 | 1.56 |
| 4 | 3.1 | 1 | 0-11 | 3.84 |
| 5 | 0.11 | 0 | 0-1 | 0.33 |
| 6 | 0.7 | 0 | 0-3 | 1.25 |
| 7 | 3 | 2.5 | 0-8 | 3.16 |
| 8 | 4.66 | 4 | 1-12 | 3.11 |
| 9 | 0.8 | 0 | 0-7 | 2.2 |
| 10 | 3 | 1.5 | 0-11 | 3.8 |
| 11 | 1.1 | 0 | 0-7 | 2.23 |
| 12 | 0.3 | 0 | 0-3 | 0.94 |
| 13 | 0.25 | 0 | 0-1 | 0.46 |
| 14 | 0.25 | 0 | 0-2 | 0.7 |

| | Unit/Hospital A | | | | Unit/Hospital B | | | | Both Hospitals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Median | Range | SD | Mean | Median | Range | SD | Mean | Median | Range | SD |
| ITU | 0.66 | 0 | 0-5 | 1.29 | 4 66 | 4 | 1-12 | 3.11 | 2.66 | 2 | 0-12 | 3.1 |
| Surgical | 1.96 | 1 | 0-11 | 2.76 | 1.63 | 0 | 0-11 | 2 9 | 1.81 | 0 | 0-11 | 2.82 |
| Medical | 1 18 | 0 | 0-8 | 2.18 | 0.26 | 0 | 0-3 | 0.72 | 0.73 | 0 | 0-8 | 1.68 |
| All | 1.28 | 0 | 0-11 | 2.21 | 2.27 | 1 | 0-12 | 2.82 | 1 78 | 0 | 0-12 | 2.74 |

## Choice of Agent for Hand Decontamination

| Ward | Mean | Median | Range | SD |
|---|---|---|---|---|
| 1 | 10.77 | 12 | 6-12 | 2.04 |
| 2 | 9.97 | 12 | 4.8-12 | 2.64 |
| 3 | 10.66 | 12 | 7.2-12 | 2.18 |
| 4 | 11.18 | 12 | 8-12 | 1.3 |
| 5 | 12 | 12 | 12 | 0 |
| 6 | 10.88 | 12 | 6-12 | 2.26 |
| 7 | 11.08 | 12 | 6.66-12 | 1.86 |
| 8 | 11.68 | 12 | 9.75-12 | 0.68 |
| 9 | 11.38 | 12 | 9-12 | 1.08 |
| 10 | 11.12 | 11.7 | 8.47-12 | 1.22 |
| 11 | 9.34 | 9.53 | 0-12 | 3.77 |
| 12 | 11.9 | 12 | 11-12 | 0.31 |
| 13 | 11.57 | 12 | 8.57-12 | 1.21 |
| 14 | 12 | 12 | 12 | 0 |

| | Unit/Hospital A | | | | Unit/Hospital B | | | | Both Hospitals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Median | Range | SD | Mean | Median | Range | SD | Mean | Median | Range | SD |
| ITU | 10.77 | 12 | 6-12 | 2.04 | 11.68 | 12 | 9.7-12 | 0.68 | 11.22 | 12 | 6-12 | 1.57 |
| Surgical | 10.62 | 12 | 4.8-12 | 2.08 | 10.61 | 12 | 0-12 | 2.47 | 10.62 | 12 | 0-12 | 2.27 |
| Medical | 11.3 | 12 | 6-12 | 1.72 | 11.82 | 12 | 8.57-12 | 0.7 | 11.56 | 12 | 6-12 | 1.32 |
| All | 10.88 | 12 | 4.8-12 | 1.96 | 11.34 | 12 | 0-12 | 1.65 | 11.11 | 12 | 0-12 | 1.82 |

## Handwashing Duration

| Ward | Mean | Median | Range | SD |
|---|---|---|---|---|
| 1 | 9.19 | 8.75 | 2.5-24 | 4.19 |
| 2 | 4.05 | 3.5 | 2-8.5 | 1.99 |
| 3 | 7.47 | 8 | 4.5-11.85 | 2.46 |
| 4 | 3.66 | 3.25 | 1-8 | 2.55 |
| 5 | 6.9 | 5.78 | 4-11.4 | 2.92 |
| 6 | 4.8 | 4.75 | 2.4-8.33 | 2.22 |
| 7 | 3.57 | 3 | 1.4-8.6 | 2.16 |
| 8 | 7.35 | 3 | 3.87-18 | 3.46 |
| 9 | 4.11 | 3.05 | 1-11.22 | 3.1 |
| 10 | 7.01 | 7.25 | 2-12.83 | 3.43 |
| 11 | 5.21 | 4.71 | 3.5-15.4 | 2.59 |
| 12 | 7.7 | 6.95 | 4-16.33 | 4.17 |
| 13 | 8.34 | 6.71 | 1.66-12.5 | 4.26 |
| 14 | 4.31 | 3 | 0-2 | 3.73 |

| | Unit/Hospital A | | | | Unit/Hospital B | | | | Both Hospitals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Median | Range | SD | Mean | Median | Range | SD | Mean | Median | Range | SD |
| ITU | 9.19 | 8.75 | 2.25-24 | 4.19 | 7.35 | 6.4 | 3.87-18 | 3.46 | 8.29 | 7.5 | 2.5-24 | 3.93 |
| S | 5.02 | 4.5 | 1-11.85 | 2.82 | 5.44 | 3.6 | 1-12.38 | 3.19 | 5.26 | 4.5 | 1-12.83 | 3 |
| M | 5.08 | 4.2 | 1.4-11.4 | 2.71 | 6.95 | 6 | 1-16.33 | 4.26 | 6.02 | 6.67 | 1.4-16.33 | 3.66 |
| All | 6.58 | 5.92 | 1-24 | 3.88 | 6.55 | 6.22 | 1-18 | 3.68 | 6.56 | 6 | 1-24 | 3.77 |

## Handrub Duration

| Ward | Mean | Median | Range | SD |
|---|---|---|---|---|
| 1 | 5.8 | 4.4 | 2-14 | 3.63 |
| 2 | 7.28 | 7.28 | 6.4-8.16 | 1.24 |
| 3 | 3.97 | 3.9 | 1-8.5 | 2.79 |
| 4 | 3.38 | 3.16 | 2-3.16 | 1.51 |
| 5 | 2 | 2 | 2 | ----- |
| 6 | ----- | ----- | ----- | ----- |
| 7 | 3.12 | 2.9 | 2.2-4.5 | 0.97 |
| 8 | 5.22 | 4.25 | 1.33-10.66 | 3.28 |
| 9 | 4.28 | 4.28 | 3.57-5 | 1.01 |
| 10 | 3.51 | 4.41 | 3-9.66 | 2.82 |
| 11 | 2.88 | 3 | 2.5-3.14 | 0.33 |
| 12 | 4 | 4 | 4 | ----- |
| 13 | 3.5 | 3.5 | 3-12 | 0.7 |
| 14 | 4 | 4 | 4 | ----- |

| | Unit/Hospital A | | | | Unit/Hospital B | | | | Both Hospitals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Median | Range | SD | Mean | Median | Range | SD | Mean | Median | Range | SD |
| ITU | 5.8 | 4.4 | 2-14 | 3.63 | 5.22 | 4.25 | 14.35-3.28 | 3.28 | 5.35 | 4.4 | 1-14.35 | 3.32 |
| S | 4.41 | 5 | 1-8.5 | 2.56 | 4.56 | 3.57 | 2.5-9.6 | 2.34 | 4.49 | 3.95 | 1-9.66 | 2.4 |
| M | 2.9 | 2.8 | 2-4.45 | 0.98 | 3.75 | 4 | 3-4 | 0.5 | 3.27 | 3 | 2-4.5 | 0.88 |
| All | 4.6 | 4.3 | 1-14 | 2.9 | 4.93 | 4 | 1-14.35 | 0.43 | 4.81 | 4 | 1-14.35 | 2.9 |

## Handwashing Surfaces Score

| Ward | Mean | Median | Range | SD |
|---|---|---|---|---|
| 1 | 9.48 | 9/06 | 7-12 | 1.69 |
| 2 | 7.68 | 8 | 4-12 | 2.51 |
| 3 | 9.57 | 9.6 | 8-12 | 1.6 |
| 4 | 7.34 | 8 | 4-12 | 2.48 |
| 5 | 9.29 | 8.25 | 8-12 | 1.69 |
| 6 | 8.26 | 8 | 6-10.4 | 1.17 |
| 7 | 6.98 | 6.66 | 4.8-9.6 | 1.76 |
| 8 | 9.06 | 8.9 | 5.33-12 | 1.56 |
| 9 | 7.06 | 6.4 | 4-11.2 | 2.25 |
| 10 | 8.55 | 8.4 | 4-12 | 2.95 |
| 11 | 8.31 | 8 | 5-12 | 2.11 |
| 12 | 8.13 | 8 | 5.33-12 | 1.66 |
| 13 | 9.4 | 9.55 | 5.14-12 | 2.33 |
| 14 | 7.95 | 8 | 4-11.33 | 2.92 |

| | Unit/Hospital A | | | | Unit/Hospital B | | | | Both Hospitals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Median | Range | SD | Mean | Median | Range | SD | Mean | Median | Range | SD |
| ITU | 9.48 | 9.06 | 7-12 | 1.69 | 9.06 | 8.9 | 5.33-12 | 1.56 | 9.28 | 8.9 | 5.33-12 | 1.6 |
| S | 8.65 | 8 | 4-12 | 2.37 | 7.97 | 8 | 4-12 | 2.47 | 8.08 | 8 | 4-12 | 2 |
| M | 8.18 | 8 | 4.8-12 | 1.76 | 8.48 | 8 | 4-12 | 2.27 | 8.33 | 8 | 4-12 | 2.0 |
| All | 8.66 | 8 | 4-12 | 2.03 | 8.58 | 8 | 4-12 | 2.09 | 8.58 | 8 | 4.12 | 2.0 |

## Handrub Surfaces Score

| Ward | Mean | Median | Range | SD |
|---|---|---|---|---|
| 1 | 9.3 | 8 | 8-12 | 1.76 |
| 2 | 8.5 | 8.5 | 5-12 | 4.95 |
| 3 | 9.67 | 10 | 8-12 | 1.4 |
| 4 | 8.12 | 8 | 5.77-11 | 1.94 |
| 5 | 8 | 8 | 8 | 0 |
| 6 | 6.67 | 8 | 4-8 | 2.31 |
| 7 | 7.26 | 7.2 | 5.6-9 | 1.31 |
| 8 | 8.34 | 8 | 4-12 | 1.54 |
| 9 | 9.43 | 9.43 | 4.8-10 | 3.64 |
| 10 | 9.29 | 9.33 | 6.4-12 | 1.82 |
| 11 | 9.33 | 8 | 6.85-12 | 2.31 |
| 12 | 8 | 8 | 6.86-12 | 0 |
| 13 | 10 | 10 | 8-12 | 2.83 |
| 14 | 8 | 8 | 8 | 0 |

| | Unit/Hospital A | | | | Unit/Hospital B | | | | Both Hospitals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Median | Range | SD | Mean | Median | Range | SD | Mean | Median | Range | SD |
| ITU | 9.3 | 8 | 8-12 | 1.76 | 8.34 | 8 | 4-12 | 1.54 | 8.58 | 11 | 4.8-12 | 1.63 |
| S | 8.79 | 9.33 | 5-12 | 2.12 | 9.32 | 8 | 6.85-12 | 2.01 | 9 08 | 9.46 | 5-12 | 2.05 |
| M | 7.14 | 8 | 4-0 | 1.54 | 9 | 8 66 | 8-12 | 2 | 7 71 | 9 | 4-12 | 1.83 |
| All | 8.55 | 8 | 4-12 | 2.03 | 8.65 | 8 | 4.8-12 | 2.16 | 8.86 | 8 | 4.12 | 1.84 |

## Drying Score

| Ward | Mean | Median | Range | SD |
|---|---|---|---|---|
| 1 | 10.24 | 11.07 | 6-12 | 1.89 |
| 2 | 9.25 | 9 | 6-12 | 2.52 |
| 3 | 9.61 | 10 | 7-12 | 1.92 |
| 4 | 7.93 | 6.75 | 6-10.8 | 2.04 |
| 5 | 9.69 | 9.59 | 6-12 | 2.21 |
| 6 | 9.12 | 9.6 | 6-12 | 2.09 |
| 7 | 8.37 | 8.4 | 6.85-10 | 0.99 |
| 8 | 10.01 | 10.5 | 6-12 | 1.89 |
| 9 | 7.84 | 7.8 | 6-9.6 | 1.25 |
| 10 | 9.78 | 10.2 | 6-12 | 2.24 |
| 11 | 10.34 | 10.4 | 6-12 | 1.88 |
| 12 | 9.34 | 9.8 | 6-10 | 2.02 |
| 13 | 7.95 | 8.16 | 8-12 | 1.59 |
| 14 | 10.4 | 10.8 | 4-11.33 | 1.7 |

| | Unit/Hospital A | | | | Unit/Hospital B | | | | Both Hospitals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Median | Range | SD | Mean | Median | Range | SD | Mean | Median | Range | S |
| ITU | 10.29 | 11.07 | 6-12 | 1.87 | 10.1 | 10.5 | 6-12 | 1.89 | 10.17 | 11 | 6-12 | 1 |
| S | 8.93 | 9 | 6-12 | 2.21 | 9.37 | 9.37 | 6-12 | 2.09 | 9.16 | 9.46 | 6-12 | 2 |
| M | 9.06 | 9 | 6-12 | 1.86 | 9.19 | 9.19 | 6-12 | 1.98 | 9.13 | 9 | 6-12 | 1 |
| All | 9.45 | 9.6 | 6-12 | 2.06 | 9.57 | 9.57 | 6-12 | 2.03 | 9.15 | 9.6 | 6-12 | 2. |

## Disposal Score

| Ward | Mean | Median | Range | SD |
|---|---|---|---|---|
| 1 | 9.78 | 12 | 0-12 | 3.49 |
| 2 | 6.8 | 7.2 | 0-12 | 5.56 |
| 3 | 9.68 | 12 | 0-12 | 4.26 |
| 4 | 8.47 | 9.5 | 6-12 | 3.8 |
| 5 | 3.41 | 0.86 | 0-12 | 4.81 |
| 6 | 7.5 | 7.2 | 4-12 | 3.11 |
| 7 | 11.45 | 12 | 9-12 | 1.09 |
| 8 | 11.77 | 12 | 7.2-12 | 0.93 |
| 9 | 7.8 | 8.4 | 2.4-12 | 4.35 |
| 10 | 7.42 | 8.49 | 0-12 | 4.37 |
| 11 | 9.92 | 9.5 | 8-12 | 1.93 |
| 12 | 7.46 | 7 | 4-12 | 2.87 |
| 13 | 0.44 | 10.47 | 4-12 | 3.02 |
| 14 | 9.8 | 12 | 3-12 | 3.39 |

| | Unit/Hospital A | | | | Unit/Hospital B | | | | Both Hospitals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Median | Range | SD | Mean | Median | Range | SD | Mean | Median | Range | SD |
| ITU | 9.78 | 12 | 0-12 | 3.49 | 11.77 | 12 | 7.2-12 | 0.93 | 10.78 | 12 | 0-12 | 2.72 |
| S | 8.54 | 8.27 | 0-12 | 4.55 | 8.37 | 8.37 | 0-12 | 3.77 | 8.32 | 10 | 0-12 | 4.12 |
| M | 7.47 | 7.45 | 0-12 | 4.59 | 8.74 | 8.74 | 0-12 | 3.13 | 8.1 | 9.3 | 0-12 | 3.94 |
| All | 8.56 | 10 | 0-12 | 4.28 | 9.66 | 12 | 0-12 | 3.24 | 9.12 | 10.8 | 0-12 | 3.81 |

## Amalgamated Handwashing Score

| Ward | Mean | Median | Range | SD |
|---|---|---|---|---|
| 1 | 9.58 | 9.76 | 6-12 | 1.51 |
| 2 | 7.37 | 8 | 4-11 | 2.29 |
| 3 | 9.35 | 9.57 | 5.89-11.28 | 1.58 |
| 4 | 6.75 | 6.78 | 4-10.57 | 1.92 |
| 5 | 7.72 | 6.89 | 5.5-11.2 | 2.17 |
| 6 | 7.77 | 7.5 | 6-10 | 1.38 |
| 7 | 7.95 | 7.97 | 6.99-9.5 | 0.88 |
| 8 | 9.88 | 10 | 7.99-4.12 | 0.96 |
| 9 | 7.07 | 6.8 | 4.5-10.1 | 2.06 |
| 10 | 8.33 | 8.05 | 5-11 | 2.25 |
| 11 | 8.64 | 8.82 | 6.99-11 | 1.32 |
| 12 | 8.33 | 8.3 | 5.58-11.4 | 2.04 |
| 13 | 8.94 | 88.72 | 7.56-10.5 | 1.1 |
| 14 | 8.6 | 8.75 | 5.5-11.83 | 2.04 |

| | Unit/Hospital A | | | | Unit/Hospital B | | | | Both Hospitals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Median | Range | SD | Mean | Median | Range | SD | Mean | Median | Range | SD |
| ITU | 9.58 | 9 76 | 6-12 | 1.51 | 9 88 | 10 | 7.99-11.64 | 0.96 | 9.73 | 10 | 6-12 | 1.26 |
| S | 7.82 | 8.5 | 4-11.28 | 2.09 | 8.01 | 7 75 | 4.5-11 | 1.98 | 8.04 | 8.35 | 4.5-11.2 | 22.01 |
| M | 7.81 | 7.5 | 5.5-11.2 | 1.5 | 8 62 | 8 6 | 5.5-11.83 | 1.74 | 8.21 | 7 95 | 5.5-11.83 | 1.65 |
| All | 8.44 | 8.75 | 4-12 | 1.87 | 8.83 | 9.25 | 4.5-11.83 | 1.78 | 8.64 | 9 | 4-12 | 1.83 |

## Number of times gloves were needed

| Ward | Mean | Median | Range | SD |
|---|---|---|---|---|
| 1 | 3.84 | 3 | 0-13 | 3.53 |
| 2 | 0.7 | 0.5 | 0-3 | 0.94 |
| 3 | 2.9 | 2 | 0-6 | 3.81 |
| 4 | 1.3 | 1 | 0-4 | 1.16 |
| 5 | 0.37 | 0 | 0-1 | 0.74 |
| 6 | 0.9 | 1 | 0-2 | 0.87 |
| 7 | 4.38 | 3.5 | 0-11 | 3.25 |
| 8 | 2.86 | 2.5 | 0-8 | 2.31 |
| 9 | 1.8 | 2 | 0-4 | 1.31 |
| 10 | 0.9 | 0.5 | 0-3 | 1.1 |
| 11 | 1 | 0 | 0-5 | 1.63 |
| 12 | 0.6 | 0 | 0-3 | 1.07 |
| 13 | 0.5 | 0.5 | 0-1 | 0.53 |
| 14 | 0.62 | 0 | 0-4 | 1.4 |

| | Unit/Hospital A | | | | Unit/Hospital B | | | | Both Hospitals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Median | Range | SD | Mean | Median | Range | SD | Mean | Median | Range | SD |
| ITU | 3.86 | 3 | 0-13 | 3.53 | 2.86 | 2.5 | 0-8 | 2.31 | 3.36 | 3 | 0-13 | 3 |
| S | 2.05 | 1 | 0-12 | 2.47 | 2.17 | 1 | 0-5 | 2.3 | 1.43 | 9.416 | 0-12 | 1.99 |
| M | 2.93 | 1 | 0-11 | 2.54 | 1.6 | 0 | 0-4 | 1.38 | 1 | 1.19 | 0-11 | 2.02 |
| All | 2.46 | 1 | 0-13 | 3.05 | 1.6 | 1 | 0-8 | 1.93 | 2.03 | 1 | 0-13 | 2.58 |

## Number of occasions when gloves were worn

| Ward | Mean | Median | Range | SD |
|---|---|---|---|---|
| 1 | 2.76 | 2.5 | 0-10 | 2.82 |
| 2 | 0.6 | 0 | 0-3 | 0.96 |
| 3 | 0.9 | 0 | 0-3 | 1.28 |
| 4 | 0.77 | 0 | 0-4 | 1.3 |
| 5 | 0 | 0 | 0 | 0 |
| 6 | 0.2 | 0 | 0-1 | 0.42 |
| 7 | 1 | 1 | 0-2 | 0.75 |
| 8 | 2.9 | 2 | 0-9 | 2.57 |
| 9 | 0.9 | 0.5 | 0-2 | 0.99 |
| 10 | 0.7 | 0 | 0-3 | 1.05 |
| 11 | 0.9 | 0 | 0-5 | 1.59 |
| 12 | 0.1 | 0 | 0-1 | 0.31 |
| 13 | 0.5 | 0 | 0-2 | 0.75 |
| 14 | 0.62 | 0 | 0-4 | 1.4 |

| | Unit/Hospital A | | | | Unit Hospital B | | | | Both Hospitals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Median | Range | SD | Mean | Median | Range | SD | Mean | Median | Range | S |
| ITU | 2.76 | 2.5 | 0-12 | 2.82 | 2.9 | 2 | 0-9 | 2.57 | 2.83 | 2 | 0-12 | 2. |
| S | 1.83 | 0 | 0-4 | 1.15 | 1.92 | 0 | 0-5 | 1.2 | 0.79 | 0 | 0-5 | 1 |
| M | 1.25 | 0 | 0-2 | 0.63 | 1.66 | 0 | 0-4 | 0-89 | 0.38 | 0 | 0-4 | 0 |
| All | 1.35 | 1 | 0-10 | 2.1 | 1.45 | 1 | 0-9 | 2.05 | 1.4 | 1 | 0-10 | 2 |

## Glovewearing Score

| Ward | Mean | Median | Range | SD |
|---|---|---|---|---|
| 1 | 5.98 | 6 | 0-12 | 4.02 |
| 2 | 7 | 9 | 0-12 | 5.9 |
| 3 | 8.2 | 9 | 0-12 | 4.92 |
| 4 | 4.67 | 0 | 0-12 | 5.83 |
| 5 | 0 | 0 | ------ | 0 |
| 6 | 4 | 0 | 0-12 | 6.2 |
| 7 | 5.37 | 2.5 | 0-12 | 5.58 |
| 8 | 8.74 | 9 | 0-12 | 3.29 |
| 9 | 5.75 | 5 | 0-12 | 5.6 |
| 10 | 8.4 | 12 | 0-12 | 5.37 |
| 11 | 9.3 | 9.6 | 6-12 | 3.16 |
| 12 | 2 | 0 | 0-6 | 3.46 |
| 13 | 9 | 12 | 0-12 | 6 |
| 14 | 12 | 12 | 12 | 0 |

| | Unit/Hospital A | | | | Unit/Hospital B | | | | Both Hospitals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Median | Range | SD | Mean | Median | Range | SD | Mean | Median | Range | SD |
| ITU | 5.98 | 6 | 0-12 | 4.02 | 8.74 | 9 | 0-12 | 3.29 | 7.34 | 7.2 | 0-12 | 3.9 |
| S | 6.57 | 7 | 0-12 | 5.56 | 7.36 | 7.2 | 0-12 | 5.04 | 6.76 | 7.2 | 0-12 | 5.28 |
| M | 4.18 | 1 | 0-12 | 5.52 | 7.33 | 12 | 0-12 | 5.83 | 5.32 | 2 | 0-12 | 5.72 |
| All | 5.61 | 6 | 0-12 | 4.93 | 8.05 | 9 | 0-12 | 4.37 | 6.71 | 6 | 0-12 | 4.82 |

## Inappropriate use of gloves

| Ward | Mean | Median | Range | SD |
|---|---|---|---|---|
| 1 | 0.9 | 0 | 0-4 | 1.34 |
| 2 | 0.1 | 0 | 0-1 | 0.31 |
| 3 | 0.2 | 0 | 0-2 | 0.63 |
| 4 | 0.11 | 0 | 0-1 | 0.33 |
| 5 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 |
| 8 | 0.46 | 0 | 0-3 | 0.86 |
| 9 | 0 | 0 | 0 | 0 |
| 10 | 0.2 | 0 | 0-1 | 0.42 |
| 11 | 0.12 | 0 | 0-1 | 0.31 |
| 12 | 0.1 | 0 | 0-1 | 0.31 |
| 13 | 0.25 | 0 | 0-1 | 0.46 |
| 14 | 0 | 0 | 0 | 0.35 |

| | Unit/Hospital A | | | | Unit/Hospital B | | | | Both Hospitals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Median | Range | SD | Mean | Median | Range | SD | Mean | Median | Range | [illegible] |
| ITU | 0.9 | o | 0-4 | 1.34 | 0.46 | 0 | 0-3 | 0.86 | 0.68 | 0 | 0-4 | 1 |
| S | 0.13 | 0 | 0-2 | 0.44 | 0.1 | 0 | 0-1 | 0.3 | 0.11 | 0 | 0-2 | 0 |
| M | 0 | 0 | 0 | 0 | 0.11 | 0 | 0-1 | 0.36 | 0.07 | 0 | 0-1 | 0 |
| All | 0.36 | 0 | 0 | 0.92 | 0.25 | 0 | 0-3 | 0.57 | 0.3 | 0 | 0-4 | 0 |

## Frequency of Sharps Use

| Ward | Mean | Median | Range | SD |
|---|---|---|---|---|
| 1 | 0.62 | 0 | 0-2 | 0.92 |
| 2 | 0.4 | 0 | 0-2 | 0.69 |
| 3 | 1.3 | 2 | 0-3 | 1.16 |
| 4 | 1 | 1 | 0-3 | 1.06 |
| 5 | 0.44 | 0 | 0-1 | 0.52 |
| 6 | 0.77 | 1 | 0-1 | 0.44 |
| 7 | 1.5 | 1 | 0-4 | 1.19 |
| 8 | 1.17 | 1 | 0-4 | 1.41 |
| 9 | 0.9 | 0.5 | 0-5 | 1.52 |
| 10 | 0.8 | 1 | 0-2 | 0.63 |
| 11 | 0.37 | 0 | 0-2 | 0.67 |
| 12 | 0.8 | 1 | 0-2 | 0.78 |
| 13 | 1 | 1 | 0-3 | 1.06 |
| 14 | 2.88 | 1.5 | 0-4 | 3.94 |

| | Unit/Hospital A | | | | Unit/Hospital B | | | | Both Hospitals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Median | Range | SD | Mean | Median | Range | SD | Mean | Median | Range | SD |
| ITU | 0.62 | 0 | 0-2 | 0.92 | 1.17 | 1 | 0-4 | 1.41 | 0.89 | 1 | 0-4 | 1.15 |
| S | 0.9 | 1 | 0-3 | 1.03 | 0.66 | 2 | 0-5 | 1.02 | 0.77 | 0 | 0-5 | 1.02 |
| M | 0.88 | 1 | 0-4 | 0.86 | 1.57 | 2 | 0-4 | 2.4 | 1.19 | 1 | 0-4 | 1.81 |
| All | 0.79 | 1 | 0-4 | 0.88 | 1.12 | 1 | 0-5 | 1.69 | 0.94 | 1 | 0-5 | 1.35 |

## Dependency

| Ward | Mean | Median | Range | SD |
|---|---|---|---|---|
| 1 | 31 | 30 | 20-45 | 8.94 |
| 2 | 38 | 36.5 | 31-49 | 6.45 |
| 3 | 50.2 | 57 | 22-71 | 19.05 |
| 4 | 35 | 37 | 25-40 | 5.52 |
| 5 | 43.44 | 45 | 28-78 | 14.99 |
| 6 | 61.25 | 64 | 45-71 | 8.56 |
| 7 | 58.75 | 58 | 43-88 | 13.91 |
| 8 | 36.17 | 40 | 25-50 | 7.73 |
| 9 | 71.7 | 72 | 48-82 | 9.82 |
| 10 | 60.9 | 61 | 43-83 | 10.92 |
| 11 | 58.7 | 58 | 48.66 | 5.08 |
| 12 | 40.2 | 34 | 33.66 | 12.26 |
| 13 | 70.38 | 65 | 60-87 | 12.11 |
| 14 | 65.38 | 64 | 61-75 | 5.32 |

| | Unit Hospital A | | | | Unit Hospital B | | | | Both Hospitals | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Median | Range | SD | Mean | Median | Range | SD | Mean | Median | Range | SI |
| ITU | 31 | 30 | 20-45 | 8 94 | 36 17 | 40 | 25-50 | 7 73 | 33.58 | 30 | 20-50 | 8 |
| S | 41.07 | 38 | 22-71 | 13 4 | 63 77 | 64 | 43-83 | 10.41 | 52.42 | 55 | 22-83 | 16. |
| M | 54.04 | 54 | 28.88 | 14.82 | 57.23 | 60.5 | 33-87 | 17 19 | 55.67 | 60 | 28-88 | 15 |
| All | 41.33 | 38 | 20.88 | 15.45 | 52.16 | 54 | 25-87 | 17 03 | 46 78 | 45 | 20-88 | 17 |

Calculating the Amalgamated Handwashing Score

The means of the duration, drying, surfaces and disposal scores were summated then divided by four to give the Amalgamated Handwashing Score for each nurse. Drying, surfaces and disposal had all originally been scored out of twelve, but duration had been computed from raw scores to avoid reducing interval to ordinal data. This was now inevitable so that duration would be in line with the other handwashing components. Scoring was according to the following scheme.

| | |
|---|---|
| 1 - 3.99 seconds | = Score 4 |
| 4 - 9.99 seconds | = Score 8 |
| More than 10 seconds | = Score 12 |

The decision to use ten seconds as a cut off point was in line with CDC recommendation (1986) in the absence of others.

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# ASSESSING NURSES' HAND DECONTAMINATION PERFORMANCE

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THE threat of nosocomial infection has been well documented[1]. It is known that immunocompromised patients requiring invasive therapies are particularly at risk[2,3] and that bacteria responsible are disseminated by direct contact, chiefly via hands[4,5]. Research undertaken in intensive care units (ICUs) demonstrated that brief touching could be sufficient to transfer $10^3$ colony-forming units to hands: Klebsiella could survive 150 minutes on nurses' hands during normal duties — long enough for cross-infection to occur[6]. It has therefore been suggested that decontamination should follow every contact, no matter how minimal or brief[7]. Whether it is reasonable to expect busy nurses to wash between each contact is open to debate, probably depending on the clinical specialty[8]. However, in wards where patients are less at risk a wide range of equipment may nevertheless result in hand contamination with potential for transfer between individuals[9]. It has long been appreciated that strict hand-washing can reduce rates of infection and colonisation during outbreaks[10].

The aim of this study was to compare hand decontamination between nurses in three different clinical settings: ICU, surgical and medical units. Data were collected from two hospitals, one with an infection control nurse and comprehensive infection control policies, the other lacking these facilities. It was intended that 30 subjects would participate, allowing comparisons to be drawn between each of the six units.

## Method

Observation was the obvious method of acquiring information. The researcher was non-participant in order to collect the necessary volume of detailed data. Each subject was observed for two hours, allowing ample opportunities for cross-infection, yet overcoming hazards of observer fatigue and consequent inaccuracies entering the data, problems encountered in previous studies[11]. Difficulties inherent in this type of research include the need to observe closely without intrusion and to judge behaviour according to established criteria for acceptable practice. This is problematic where such criteria do not exist. In the USA, centres for disease control stipulate that hands should be washed for at least 10 seconds during a standard nursing shift[12], but in the UK no similar recommendations exist, so the same criteria have been employed regardless of the popularity of different agents. In the UK chlorhexidine is favoured because of its superior bactericidal effects shown to persist after initial application[13], while alcoholic hand-rubs incorporating chlorhexidine are not widely used in the USA[14].

In previous studies authors have judged the appropriateness of decontamination according to Fulkerson's scale devised by Fox et al.[15] for CDC. This system of ranking activities as 'clean' or 'dirty' relative to one another is acknowledged to be arbitrary[16]. It was therefore decided to judge appropriateness in two distinct ways. According to the 'rigorous approach', decontamination would be considered mandatory following every clinical contact, as recommended by Albert and Condie[7]. According to a second, 'liberal approach' taken by Broughall et al.[17] collecting data in general wards, some tasks would be considered dirty on the basis of the literature and the context within which they occurred (Fig 1).

Technique of decontamination has previously been judged according to Feldman's criteria validated by Larson and Lusk[18]. However, this proved too cumbersome for the present study and did not appear to provide an accurate representation of the variables likely to contribute to excellence of practice on the evidence of the literature. It was replaced by independent assessments of five components of hand-washing performance (agent chosen, duration, number of surfaces decontaminated, drying and disposal) identified during pilot work. Each component was scored individually but out of the same total score (12), as the relative importance of each was unknown (Fig 1).

## Results

*Frequency and appropriateness*

Mean number of clinical contacts was 24.01 over two hours. The ICU in Hospital A was significantly busier than those elsewhere. Throughout this time nurses decontaminated 6.67 (28.78%) times on average, so that by extrapolation 26.68 decontaminations would be performed during an eight-hour shift. There were differences between hospital and clinical setting when statistical tests were performed and examination of percentage frequencies was illuminating: hands were decontaminated on 35.86% occasions in the ICU in Hospital B compared to only 22.9% in the ICU of Hospital A. These results represented the extremes of practice, results from all other areas falling between the two. When essential decontaminations were considered, frequency was 11.42 (49.85%), again with superior results from the ICU in Hospital B.

**SUMMARY:** There have been numerous attempts to assess the frequency and technique of nurses' hand decontamination, but criteria employed to define acceptable levels of practice are questionable, while comparisons between staff in different clinical settings appear never to have been undertaken. In the study reported here tight criteria were developed to evaluate performance, then used to compare nurses employed in three clinical settings: intensive care, surgical and medical units. Two hospitals were employed, one with an infection control nurse, the other without. Frequency was highest in the ICU of the second hospital, but technique was superior in ICUs regardless of hospital. Half of all opportunities for essential decontamination were, however, omitted. Technique appeared superior to earlier reports. Alcoholic hand-rub was readily available and used more often in the unit where the best practice was witnessed.

**Fig 1. Scoring system for all facets of hand decontamination**

*Duration*
Raw data in seconds taken as the score for each episode.

*Frequency/rigorous approach*
There was enormous variation in the number of patient contacts made during each period of observation. Frequency was therefore calculated as the percentage of hand decontamination episodes made during the two hours: that is, if 50 contacts occurred but hand decontamination followed only 10 times, frequency would be calculated as 5%

*Appropriateness of timing (using two scores, calculated as percentage of total mandatory decontamination)*
A The rigorous approach — the same as the frequency score above.
B The liberal appropriateness score[17].

| *Choice of appropriate agent* | *Score* |
|---|---|
| No agent-bar soap | 0 |
| Inappropriate agent | 6 |
| Appropriate agent | 12 |

| *Number of surfaces decontaminated* | *Score* |
|---|---|
| One hand surface decontaminated | 4 |
| Two hand surfaces decontaminated | 8 |
| Three hand surfaces decontaminated | 12 |

| *Thoroughness of drying (excluding hand-rub)* | *Score* |
|---|---|
| Thorough drying | 12 |
| Drying not thorough | 6 |
| No attempt made to dry | 0 |

| *Disposal (excluding hand-rub)* | *Score* |
|---|---|
| Disposal without contaminating hands | 12 |
| Hands recontaminated | 0 |

We examined the frequencies of hand-washing and hand-rub use independently. For hand-washing there was no significant difference between hospital or unit, but hand-rub was used much more often in the ICU in Hospital B.

*Technique*

Appropriateness of the agent was judged during preliminary analysis. Scores were high (11.11 out of 12): in two wards all nurses received the top marks. Scores were highest in medical units and lowest in ICUs, regardless of the hospital where data were collected. However, all other aspects of hand-washing technique were performed significantly better by ICU nurses irrespective of hospital. Duration was 6.56 seconds for the entire sample but 8.29 seconds for ICU nurses.

Similarly, surfaces score for the sample overall was 8.58, but ICU nurses scored 9.28. The interdigital surface was omitted most often. Drying score was 9.51 for the complete sample but 10.17 in ICU nurses. Many nurses scored the maximum on this dimension. There were no recorded incidents when drying was omitted. Finally, disposal score was 9.12 for the complete sample but 10.78 in ICU nurses.

The possible relationship between each of these five aspects of hand-washing was examined. Four components (duration, drying, surfaces and disposal) demonstrated significant positive correlation ($p<0.005$) with Spearman's Rank Correlation Coefficient. Moreover, when these scores were summated and correlated with the score for each individual component significant results were again achieved ($p<0.001$) except for choice of agent. It was therefore possible to accept that a nurse performing well in one aspect of hand-washing would perform well in all others apart from choosing the most appropriate agent. It was therefore possible to calculate an overall score to assess hand-washing technique, the Amalgamated Hand-washing Score. Its mean for the entire sample was 8.64 and, as anticipated, results were superior for ICU nurses whose mean score was 9.73. However, further correlations revealed that technique bore no relationship to frequency irrespective of criteria (rigorous or liberal) employed to judge it. Thus nurses who washed hands most often did not necessarily wash them most carefully, although it could be argued that the best practice was achieved in Hospital B's ICU where the most superior technique was recorded as well as the greatest frequency.

The individual components constituting hand-rub use included choice of agent, duration and surfaces decontaminated. Duration for the sample considered as a whole was shorter than for hand-washing (4.81 seconds) with no difference between hospital or clinical setting. Surfaces score was 8.60. Again, the performance of all nurses was similar, but as with hand-washing the interdigital surface was omitted most frequently. There was no correlation between the individual components of hand-rub use, so it was not feasible to calculate an overall score to assess technique. However, when each of the individual components was examined in relation to frequency a significant negative association was found in conjunction with surfaces score: $r_s=-0.271$ $p<0.005$. This indicated that as frequency increased, decontamination with hand-rub became less thorough.

To complete the analysis the relationship between the common components of hand-washing and hand-rub duration was compared and found to be significantly different. From the means it was apparent that hands were decontaminated longer (1.75 seconds) when hand-washing was performed : $W=21378$ $p<0.0004$. Surfaces scores were similar regardless of agent.

## Discussion

*Frequency*

Decontamination frequency exceeded the widely quoted criterion of 10 times per shift recommended by CDC[12] but did not approach the very high levels observed by Ojajarvi et al.[19] considered to be damaging through the tendency to abrade skin, thus increasing rates of bacterial carriage[20,21]. However, even with the much lower levels seen here, many subjects remarked on their sore, dry hands. This was attributed to the need to decontaminate often, especially when chlorhexidine was used, and replicated earlier findings relating to dislike of this agent[22]. Frequency was somewhat higher than rates reported by others, whether obtained through direct observation[23] or monitoring devices attached to taps[17,24].

*Appropriateness*
Nurses in this study performed less well than in the study by Albert and Condie[7] whose finding that in ICUs hands were decontaminated after 42% patient contacts rather than the 100% ideal recommended is widely quoted as evidence of poor practice. The results of the present study (28.78%) are similar to rates quoted by Larson et al.[25] from the Third World under most unfavourable circumstances and from other units prior to educational campaigns intended to increase compliance (Conly et al. 29%, Graham 32%[26,27]). Particularly noteworthy are the extremes of practice recorded in the two ICUs where it had been anticipated that performance would be universally superior to that in wards. The reason for this finding is obscure, especially as the best practice in terms of frequency and appropriateness was detected in the second hospital where there was no infection control nurse to monitor standards.

When essential decontaminations were considered separately, performance appeared somewhat better (49.85%), although hands were still decontaminated half the time that this was absolutely necessary. It is pertinent that fewest decontaminations in percentage terms occurred in the ICU of Hospital A, also the unit where most clinical contacts were initiated, a result supporting the finding of Haley and Bregman[28] that when staff were busy hand hygiene became difficult to maintain. The negative correlation between number of essential decontaminations and number of hand surfaces covered with hand-rub suggests that this agent was sometimes used as a short cut but that staff realised that decontamination was vital. ICU nurses in Hospital A used hand-rub less often than other subjects, although it is particularly suitable in critical care situations when moving rapidly between tasks involving the same patient[14]. This probably related to availability; hand-rub was recommended for ICUs in the infection control document but was seen to be in short supply during fieldwork.

Caution must be exercised when evaluating these results, as the approaches adopted by Albert and Condie [7] and Broughall et al.[17] may have evolved as products of the settings in which these teams collected data. In ICUs, where patients are immunocompromised and have many invasive devices known to increase risks of infection[2,29], it is perhaps more reasonable to expect decontamination after brief contact. Broughall's team may have adopted different criteria because their study took place in a general ward.

Possibly criteria employed to judge acceptable practice should also vary according to the clinical setting. However, overall results relating to appropriateness in the present study compare unfavourably to those of Taylor[16] who reported that decontamination occurred after 59% of activities categorised as 'dirty' and Sedgwick[30] who noted that, although decontamination was otherwise haphazard, it generally followed obviously dirty tasks.

*Technique*
All previous authors concluded that hand-washing technique was poor, but direct comparison with their results is difficult because all former assessments were made with Feldman's criteria, judged during pilot studies not to be valid as well as too complex for use during fieldwork. According to the results of the Amalgamated Hand-washing Score, technique was moderately good but with scope for improvement, even in ICUs where the best practice was encountered. Very few individuals achieved the maximum score on any occasion.

As it fulfils the criteria of a psychomotor skill defined by de Tornyay and Thompson [31], considered important by nurse educationalists[32], hand-washing technique should be open to improvement, although campaigns to enhance practice appear to have focused more on increasing knowledge of infection control[24] or boosting frequency[26,27]. Other authors commenting on technique remark on its variation between members of staff despite individual consistency. Possibly these findings emerged because the studies were small scale[16,30] or, in the case of Larson et al.[23], involved the same 22 subjects over several months. It was not possible to corroborate this finding with the more limited data for each subject here, but increased workload was not linked to alteration in the Amalgamated Hand-washing Score, suggesting that it may be difficult to change.

Most authors discuss duration independently of technique. Only modest correlation ($p=0.05$) has been detected[23], although it has been reasoned that duration is likely to relate to thoroughness because a longer interval spent washing provides greater opportunity for decontaminating all surfaces[33]. Overall duration in the present study (6.56 seconds) fell short of the 10 seconds minimum recommended by CDC[12] and the findings of other authors[17,27,34] who also quote wide ranges in the amount of time spent decontaminating between individuals, again not reflected here.

In the present study the longest hand-wash lasted 28 seconds, once for one subject, whose overall mean was 18 seconds. None of the above authors were able to demonstrate association between duration and decontamination following activities likely to result in heavy contamination, a finding reproduced here. As in Linden's study[11], omission occurred most often in relation to the interdigital surface.

Drying helps to remove bacteria remaining after washing[35], especially when non-medicated agents are employed[36]. According to the results of this study drying was superior in ICUs, where chlorhexidine was always available and less good in wards where, in Hospital A, the infection control policy stipulated that soap should be employed for aseptic technique. This was probably of minor significance, however, as drying was generally satisfactory (9.51), many nurses scoring the maximum. Drying is seldom mentioned in other studies but was reported poor by Gidley[37].

Disposal is not mentioned separately in other studies. The superior results obtained from ICUs were anticipated, as open plastic bags were available to accommodate clinical waste at every bedside, whereas in wards pedal bins performing the same function were often broken so that nurses were obliged to lift lids manually.

Attempts to assess hand-rub use were less successful. It was not possible to calculate an overall score because potential components failed to correlate. This apparent lack of association may be owing to inaccuracies in data collection inevitable through speed of events, especially as there may have been a tendency to resort to hand-rub when busy. The short duration compared to hand-washing supports the findings of Ojajarvi et al.[19], although in these trials fewer surfaces were decontaminated because there was insufficient time to decontaminate thoroughly, a finding not reproduced here. Ojajarvi[21] later overcame this by incorporating emollients to increase viscosity, thus preventing the alcohol from 'slipping through the fingers' rapidly. Quantity of agent varies between subjects[38], smaller amounts being employed when alcohol rather than traditional agents is used[39].

## Conclusions

In this study, more tightly controlled than others within the literature, hands were decontaminated more often than in many previous studies, yet half of all essential decontaminations were omitted. Technique appeared superior to earlier reports, although unrelated to frequency and appropriateness. Frequency suffered with increasing workload, but hand-washing technique, superior in ICUs regardless of hospital, was not influenced by external factors such as workload and the presence of an observer.

The presence of an infection control nurse in the first hospital exerted no demonstrable impact on nursing behaviour, a result concording with Cadwallader's[40] conclusion that the advice of infection control experts is of most benefit when supported by commitment from clinical staff. Aspects of hand-rub technique were more difficult to document, but as it was apparently used more often when staff were very busy (providing that it was available) the link between higher frequency and tendency to decontaminate fewer surfaces is understandable. Under such circumstances it is commendable that decontamination was attempted at all. Ensuring adequate provision of hand-rub thus appears worth while.

## Recommendations for practice

The findings of this study indicate the need for clinical nurses to reconsider hand decontamination practice. Although technique appeared better than in previous studies there was scope for improvement: even in the unit with superior performance scores were not optimal. To reverse this trend learners could be taught sound technique early in their courses, and the need for maintaining optimal practice could be reinforced as part of continuing education. The results of this study suggest that technique is not altered with heavy workload, so that, once established, good performance should persist. Appropriate use of hand-rub with emphasis on technique could also be promoted. Also worth while would be reminders to decontaminate appropriately, pointing out activities likely to result in heavy contamination. The use of agents with residual bactericidal effect deserves encouragement as this helps to overcome difficulties encountered when very busy. Infection control nurses and managers could support clinical staff by ensuring that appropriate resources are wisely deployed. **NT**

**EDITOR'S COMMENT:** The second paper in this series on ward-based nursing is a rigorous study, examining hand-washing in wards through painstaking data collection. As this is clearly necessary to obtain reliable results the researchers must be congratulated. Analysis and comparison of these data are clearly useful. Recommending sensible approaches and indicating when decontamination is essential should also be seen as a step forward. By reviewing what is possible, more realistic policies may be followed.

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# Nurses' hands as vectors of hospital-acquired infection: a review

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**Nurses' hands as vectors of hospital-acquired infection: a review**
Hospital-acquired infections (HAI) are notorious for the manner in which they complicate the course of the original illness, increase costs of hospital stay and delay recovery. This review will briefly outline the problems presented by HAI in developed countries and present evidence that *Staphylococcus aureus* and gram negative bacilli, the main causative agents, reach susceptible patients via the contact rather than airborne route, predominantly on the hands of hospital staff. Good hand hygiene could help reduce the economic burden and patient distress caused by HAI, but there is evidence that it is infrequently and poorly performed by nurses, the health care staff most frequently in continuous contact with patients. Possible reasons are explored in an attempt to identify strategies to improve hand hygiene.

## INTRODUCTION

Hospital-acquired infections (HAI), defined as infections which are neither present or incubating before hospital admission (Scheckler 1978), are notorious for their economic burden on the health service and distress brought to patients. In consequence, the epidemiology of HAI has attracted considerable research attention, though precise current costs are difficult to establish and complicated to calculate if all relevant factors are considered, yet rapidly become outdated (Dixon 1978, Rubenstein *et al.* 1982).

### Scale of the problem

In Britain and the USA, HAI occurs with greatest frequency among surgical patients. The site most frequently affected is the urinary tract, particularly among catheterized patients, followed by wounds and the lower respiratory tract (see Meers *et al.* 1981, Scheckler 1978). A retrospective study of 16 literature reports between 1933 and 1973 revealed that hospital stay was prolonged between 1·3 to 26·3 days as a result of HAI (Brachman *et al.* 1980). HAI contributes directly to morbidity and to mortality (Gross *et al.* 1980), especially among the most debilitated patients (Britt *et al.* 1978), who are most likely to be immunocompromized (Zimmerli 1985). HAI most commonly results from bacteria which are present on the skin.

## NORMAL SKIN FLORA: APPLYING KNOWLEDGE TO THE DEVELOPMENT OF HOSPITAL-ACQUIRED INFECTIONS

Reybrouck (1983) affirms that knowledge of normal skin flora is of value in the prevention of HAI because it provides the basis for our understanding of the significance and incidence of different types of bacteria carried on skin, especially hands, and suggests how this information can be applied to develop effective hand hygiene policies. This rational approach is not without problems, as the demarcation between what constitutes normal and abnormal is often hazy (Schaechter 1989). Extensive studies by Noble & Sommerville (1974) determined the composition of normal skin flora to be coagulase negative Staphylococci and Corneybacterium. Greater discrepancy reigns over numbers and location. A sensitive biopsy method described by Selwyn & Ellis (1972) suggests considerable variation in bacterial counts on different parts of the skin, with a much higher density in moist than dry areas.

Healthy intact skin resists bacterial invasion, both because it exhibits a degree of self-disinfection towards contaminants and because under normal circumstances its delicately balanced ecosystem of commensal organisms help to keep foreign species at bay. However, contamination can sometimes result in longer-term colonization by extraneous bacteria, especially when the skin is unusually moist or damaged (Ojajarvi 1979), a factor of considerable importance when considering prevention of cross infection.

Transfer of bacteria from one part of the body to another site, normally free of organisms, may result in infection: the damp perineal skin of patients with spinal cord injuries may, for example, become colonized with coliforms (Sanderson & Weissler 1990). Migration into the bladder via a urinary catheter results in bacteriuria (Sanderson & Rawal 1987). Also relevant is the tendency of hospital patients to acquire a skin flora different to that of the general population (Montgommerie & Morrow 1978) which may contaminate their immediate environment providing opportunities for cross infection. Its constituent bacteria may be more antibiotic resistant than the skin flora of healthy adult members of the general population (Larson *et al.* 1986).

Considerable attention has been paid to the normal flora of the hands. Nearly 50 years ago, Price (1938) distinguished between 'resident' and 'transient' bacteria through quantitative laboratory handwashing studies. Those organisms which could eventually be removed by repeated and thorough handwashes were categorized as transient, thought at the time to represent contaminants which under normal circumstances would probably die within 24 hours of inoculation. The remaining resident bacteria, regarded as the true skin flora, persisted deep in the ducts of sweat glands and subungal spaces. The existence of transient and resident hand flora on the basis of whether or not they can be removed by strict hand hygiene has since been verified by Hann (1973) and Gross *et al.* (1979), but it has become apparent that contaminants, especially gram negative species, may be carried for weeks or months (Cooke *et al.* 1981, Larson 1981). Hand carriage among approximately 20–30% of hospital staff has been reported (Bruun & Solberg 1973, Adams & Marrie 1982), but isolation rates of up to 80% have been mentioned in relation to neonatal and burns units (Knittle *et al.* 1975). Wearing rings increased carriage rate of underlying bacteria during field studies (Hoffman *et al.* 1985), but laboratory experiments have yet to demonstrate any increased risk of cross infection from bacteria beneath rings (Jacobson *et al.* 1985).

Reybrouck (1983) emphasizes that isolation of the same bacterial strains from patients and the hands of hospital staff reported in numerous studies does not constitute absolute proof of cross infection, but it is highly suggestive, especially today with sensitive methods of serotyping bacteria, and evidence of successful control of outbreaks once a strict handwashing regime has been implemented. More definite evidence of cause and effect may never become available when investigating cross infection, especially by the contact route (Stamm *et al.* 1981).

Today, the agents responsible for most HAI are *Staphylococcus aureus* and gram negative rods, with other pathogens sometimes responsible for outbreaks. In all cases there is sufficient evidence to demonstrate that spread is primarily via the contact route, with hands, the part of the body in most continuous contact with patient and environment, probably playing a major role. The role of airborne spread and the inanimate environment as a source of HAI will now be explored, concluding that these are of much less significance.

### Staphylococcal infections

During the 1950s, Staphylococci were recognized as responsible for increasing rates of HAI (Goodall 1952, McDermott 1956) and their ability to develop antibiotic resistance was an emerging problem (Colebrook 1955). Early work focused on air dissemination via skin scales as a possible route of spread, particularly from some members of staff identifiable as 'heavy dispersers'. Experiments with medical students demonstrated that approximately 14% of the male population acted as persistent perineal carriers of *Staph. aureus.* Dispersal of free bacteria into the air could occur during exercise in a special chamber (Ridley 1959), but under normal circumstances these would probably attach themselves to clothes. Nasal carriage was reported as more widespread, but field and laboratory studies indicated that dissemination usually occurred not directly through the air in droplets, but by an indirect route in which nasal secretions were first found to contaminate skin, clothing and probably hands (Hare & Thomas 1956). It was suggested that limited transfer might occur via friction or air currents, but later investigations involving the use of a slit sampler to detect airborne transmission during a major staphylococcal outbreak revealed that, if this occurs at all, it operates over only very short distances (Peacock *et al.* 1980).

These observations confirm the results of ingenious field studies which today would probably be prohibited on ethical grounds (Mortimer *et al.* 1966). These were conducted in a neonatal unit to trace spread of Staphylococci and Streptococci from babies already colonized between nurses and other infants. There was very little spread from nurses to infants who were in proximity but not touching. When contamination via the airborne route was prevented, a 43% transmission rate occurred from colonized to previously uncolonized babies, providing the nurse did not wash hands between contacts. Antiseptic handwashing reduced transmission rate to 14%.

Airborne spread of Staphylococci remains a major problem in theatre, especially where orthopaedic prostheses are implanted (Jalovaara & Puranen 1989) and also in burns units where patients have lost large areas of skin, the body's chief defense against infection (Ayliffe & Lowbury 1982). In the ward, hazards of airborne spread, including over short distances from skin scales on clothes, appear to have been over-estimated (Mackintosh 1982). Babb *et al.* (1983) demonstrated that even when clothes are heavily contaminated by Staphylococci released in large numbers from a heavily discharging wound, this does not appear to represent a significant threat to other patients on the same ward.

Unfortunately, the introduction of new synthetic penicillins which brought dramatic improvements in the treatment of Staphylococcal infections throughout the 1960s allowed complacency to develop (Cafferkey *et al.* 1985), while promoting multiply resistant Staphylococcal strains. Consequently, the 1970s and 1980s have been punctuated by repeated epidemics of methicillin resistant *Staphylococcus aureus* (MRSA) throughout the world. Policies for control vary according to available facilities and circumstance (Spicer 1984), but exhaustive investigation of outbreaks indicates that hands offer the chief means of spread, with critically ill patients who become colonized or infected operating as reservoirs (Thompson *et al.* 1982). Nurses can become carriers, contributing to risks of cross infection (Shanson 1985), a factor which may cause anxiety in their professional and personal lives (Tuffnell 1988).

## Gram negative bacteria

Unlike Staphylococci, gram negative bacteria do not generally resist dessication and control can be effected to a large extent by providing an environment that is clean and dry (Maurer 1985). They tend to colonize patients who are immunocompromized and, once again, infection is more likely to follow colonization (Moody *et al.* 1972). Initial studies by Lowbury (1969) suggested that most gram negative bacteria dry out and die rapidly when inoculated onto human skin, a conclusion since substantiated by Cooke *et al.* (1981) who established that species and strains previously responsible for hospital outbreaks were able to survive significantly longer than 'non-outbreak' bacteria when artificially inoculated onto the hands of laboratory volunteers.

Persuasive evidence for the hands as vectors of hospital-acquired gram negative sepsis is provided by Casewell & Phillips (1977) who demonstrated that 16% of staff in an intensive care unit had Klebsiella hand contamination of the same serotypes as those colonizing patients. Laboratory experiments showed that bacteria remained viable up to 150 minutes following artificial inoculation onto the hands — sufficient time for cross infection to occur during normal nursing duties. Clothing, ward air and dust samples were seldom contaminated, supporting work reviewed earlier by Noble *et al.* (1976) which concluded that, although some individuals disperse gram negative bacteria heavily, there is no evidence to support airborne spread. Continued work over a 4-year period demonstrated that 24% of 2315 critically ill patients became colonized with Klebsiella, almost always with the same capsular strains (Casewell & Phillips 1978). Possession of a mucus covering, not carriage of an antibiotic-resistant plasmid, was apparently the influential factor in bacterial survival on finger tips (Casewell & Desai 1983). Outbreaks of gram negative infection have been traced to nurse carriers and arrested when culprits were removed from patient contact (Burke *et al.* 1971).

## Hand carriage of pathogenic organisms

From time to time, nurses' hands must inevitably become contaminated with pathogenic organisms, especially as there is evidence that bedpan washers and disinfection procedures do not adequately destroy all enteric pathogens (Curie *et al.* 1978, Block *et al.* 1990). Survival on hands is possible for some hours (Samandi *et al.* 1983) and the hands of patients may also become contaminated, increasing risks of cross infection (Lawrence 1983, Pritchard & Hathaway 1988).

A study by Black *et al.* (1981) is one of the few experimental studies designed to show a causal link between handwashing and risk of infection. Following the introduction of a strict handwashing programme in a day care centre, the incidence of diarrhoea among children in the study centre was significantly and consistently lower than in control centres over a 35-week period. Larson (1988), remarking on the paucity of prospective clinical trials to test a causal link between hand hygiene and HAI, attributes their absence to pioneers of the mid-nineteenth century (Semmelweis, Lister and Nightingale) who effected such dramatic reductions in morbidity and mortality from infection by implementing hygiene into health care that antisepsis has too long been recognized as important and beneficial for research withholding it to be considered viable on ethical grounds. Most evidence comes indirectly from studies already reviewed here. However, if evidence for a direct link between hand hygiene and HAI is lacking, it is provided by work with respiratory pathogens which appear to depend to a large extent on spread by the contact route (Gwaltney *et al.* 1978). Prevention is achieved when hand hygiene compliance is good (Leclair *et al.* 1987).

## HANDS AND INANIMATE ENVIRONMENT

The surrounding environment has little bearing on rates of HAI (McGowan 1981, Bauer *et al.* 1990). This is confirmed by Maki *et al.* (1982) in a 'natural' experiment, possible when a hospital moved from old to new, more spacious premises where facilities (including improved ventilation intended to reduce airborne spread) had been upgraded. Extensive microbiological surveillance before and after the move revealed that despite greater environmental contamination in the older building, rate of HAI remained unchanged.

A few authors have apparently incriminated the environment in HAI, but in all cases a link between environment and susceptible patient must logically exist. Bentham (1979), describing an outbreak of Klebsiella, suggested that the floor around a leaking bedpan macerator had acted as a reservoir, but acknowledges that the route from floor to patient was probably via nurses' hands, unwashed after removing overshoes. Similarly, Carter (1990) demonstrated high counts of aerobic bacilli on the floor of an intensive care unit and on nurses' hands. Transfer could never be verified absolutely, but is suggested to have occurred in the same way.

### Links between faulty hand hygiene, equipment and HAI

Invasive devices bypassing the body's natural barriers to micro-organisms vastly increase risks of HAI (Tafuro & Ristuccia 1984). Mulhall (1990) points out that although doctors are usually responsible for siting intravenous cannulae, catheters and endotracheal tubes, nurses look after them, providing care which, though routine, is complicated. Rates of infection related to particular types of equipment show considerable variation according to the findings of an extensive multicentre incidence study (Nystrom *et al.* 1983), although there is little doubt that high dependency patients undergoing more procedures are at greatest risk (Daschner 1985). There is also some evidence that risk of sepsis is increased when new techniques are introduced with which staff have limited experience.

A prospective survey by Dumas *et al.* (1971) drew attention to high levels of contamination associated with intravenous volume control sets, linked to poor maintenance (leakage, dirty injection ports) and breaches in asepsis, especially handwashing. Later prospective studies recorded lower infection rates explained through new, less easily contaminated designs of equipment and the simultaneous development of strict protocols for asepsis (Buxton *et al.* 1979, Shinozaki *et al.* 1983, Leroy *et al.* 1989). Where aseptic technique broke down, infection was more likely to supervene. This evidence lends weight to HAI being dependent mainly on the contact route for spread, with hands, which manipulate equipment, playing a vital role.

### Handwashing performance

Over the years, the results of microbiology and field studies have indicated repeatedly that scrupulous hand hygiene remains the single most important factor favouring reduction of HAI (Lowbury *et al.* 1970, Larson 1981, Larson 1989), a suggestion which should be welcomed, as hand hygiene is relatively uncomplicated and inexpensive. Its aim is to remove all non-resident micro-organisms to below the level necessary to constitute an infective dose before transfer can occur to a susceptible patient.

Although a quick, perfunctory handwash with soap and water followed by brisk drying has been reported in one study to remove transient bacteria (Sprunt *et al.* 1973), field and laboratory studies have reached agreement on the superiority of skin disinfectants (e.g. chlorhexidine and povidone-iodine), providing the handwash is long enough for them to exert effect. Some of these agents exert a culminative effect if used repeatedly, which soap and water does not, but it is important to recognize that any agent sufficiently gentle for application to human skin will not destroy or remove all existing bacteria.

The evaluation of handwashing is a complicated task comprising not only choice of appropriate agent, but also frequency, duration, appropriateness (whether hands are washed when they should be) and performance of technique (Larson & Lusk 1985). Research has consistently shown that all aspects may be faulty.

Albert & Condie (1981) surveying frequency of handwashing in an ITU over 10 14-hour periods, observed that staff washed their hands less than half the time following patient contact. Their criterion for 'contact' was strict, as it involved minimal touching (e.g. pulse taking), but is probably justified as Casewell & Phillips (1977) demonstrated that such activities can result in transfer of $10^3$ CFU (colony forming units) to nurses' hands. This may be sufficient to constitute an infective dose or result in colonization if transferred to a very debilitated patient: the study was undertaken in ITU.

Albert & Condie (1981) did not attempt to document appropriateness. This issue has been addressed by Taylor (1978), who established during 129 observations of handwashing episodes that nurses did not distinguish between clean and dirty situations, a finding later corroborated by Broughall *et al.* (1984). Taylor attributed this to nurses' apparent belief that, unless visibly soiled, hands cannot spread infection, although her research was not designed to test this. Handwashing duration is often brief (Quraishi *et al.* 1984), averaging 8·8 seconds according to Graham (1990), compared to 10 seconds recommended by CDC.

A possible criticism of many studies is that presence of an observer may have influenced normal behaviour, even though staff were not told the real purpose until after data collection was complete in most cases. However, Leonard (1986) and Larson *et al.* (1986a) have both commented on the enormous variation in handwashing frequency between different nurses, suggesting that for a task as routine as handwashing there is little evidence of Hawthorn Effect. This problem was overcome altogether by Broughall *et al.* (1984), who recorded handwashing frequency by a monitoring system attached to soap dispensers found in trials to operate with 93% accuracy. Nurses washed hands on an average of 5–10 times per shift, but claimed to do so more often when asked to rate frequency by the research team, a finding substantiated by Larson *et al.* (1986b).

In most studies, authors have attempted to rate only a few of the factors suggested by Larson & Lusk (1985), perhaps because such close and detailed observation is time consuming and difficult to organize, especially when the research design demands that staff should be kept unaware of the true purpose of the study. Performance of technique has been examined least of all, notably in one of the smallest scale studies (Taylor 1978). Quality of handwashing tended to be poor, with some surfaces omitted repeatedly.

In recent years, health care professionals have become concerned not only with preventing HAI but also protecting themselves against blood borne pathogens (HIV, HBV) by wearing gloves when handling blood and body fluids. This has led to confusion about the need to wash hands after gloves have been removed, as some authors claim this may not always be necessary (Jackson & Lynch 1984). This view is erroneous: gloves can become punctured in use (Korneiwicz *et al.* 1989), allow passage of virus particles even when intact (Korneiwicz 1989), split under pressure (Dalgleish & Malkovsky 1988) and promote multiplication of skin bacteria by creating warm, moist conditions (McGinley *et al.* 1988). They must be changed between every patient as they cannot be washed free of pathogens (Doebbeling *et al.* 1988).

## EXPLORING REASONS FOR POOR HAND HYGIENE

The need to reduce HAI has been recognized during the development of quality assurance programmes in view of the clear relevance to patient safety and tangible economic return coupled with the relatively measurable nature of infection rates (Shaw 1986). However, Cadwallader (1989), disappointed after the implementation of a new infection control policy, concluded that the expertise of microbiologists and infection control nurses will be of limited benefit in the absense of commitment from nurses who must implement their suggestions. Lack of motivation and accountability for HAI on an individual basis may be contributory factors (*Nursing Times* News 1991). A questionnaire study by Larson & Killien (1982) sought to identify factors which influenced staff to wash or not wash hands. Individuals were aware of the need to reduce HAI but were deterred through the possibility of developing sore, dry skin. The authors judged that future compliance might be secured by closer examination of deterrent factors. A study in the Far East identified tactics employed by infection control nurses to secure compliance and asked clinical nurses to identify which approaches they found most helpful (Seto *et al.* 1990). Specialist and ward nurses found trust based on professional respect mutually more beneficial than coercion or threats from senior staff. In the UK, infection control nurses do not occupy line managerial positions in the nursing hierarchy and it is difficult to imagine coercion having much impact in hospitals in our society.

Lack of resources may be an issue related to motivation. Observing that nurses tended to wash hands more often at a sink positioned near the nurses' station, Broughall *et al.* (1984) proposed that more sinks placed nearer to the patient care areas might increase compliance. A study by Kaplan & McGucklin (1986) found supporting evidence, but Preston *et al.* (1981), documenting handwashing and infection rates before and after the upgrading of an ITU, did not.

Even when facilities are good staff may not wash hands because they have developed sore, dry skin, itself undesirable as this increases bacterial colonization (Ojajarvi 1981). Nurses are well aware of these risks (see Larson &

Killien 1982). A questionnaire study by Newsom *et al.* (1988) established that choice of hand scrub preparation depended mainly on skin tolerance. This problem is not insurmountable as manufacturers are now paying increased attention to product acceptability. Recent trials have demonstrated that cleansing with disposable alcoholic wipes incorporating emollients (Jones *et al.* 1986, Butz *et al.* 1990), antimicrobial gel (Newman & Seitz 1990) or an emulsion to replace soap and water (Kolari *et al.* 1989) can reduce cracking, drying and erythema while effectively removing transient bacteria.

Related to availability and acceptability of resources is the issue of being too busy to use them. Throughout the literature, there are numerous suggestions that at very busy times hand hygiene is more likely to break down (Lowbury *et al.* 1970, Noone *et al.* 1983), although Taylor (1978), in a small-scale observation study, could not relate levels of ward activity to handwashing. Haley & Bregman (1982), employing a multivariate statistical model, correlated under-staffing and overcrowding in a neonatal nursery to cross infection culminating in a staphylococcal outbreak. In contrast to subjects in the study by Broughall *et al.* (1984), these nurses and doctors recognized and were concerned about defects in hand hygiene when busy.

### Local policy

Local policy may influence handwashing and glove wearing specifically in relation to catheter care (Crow *et al.* 1988), though in this study medical speciality, diagnosis and reason for catheterization did not. Similarly, Ho-Yen *et al.* (1984), employing a questionnaire to evaluate nurses' knowledge of hepatitis B, could find no difference between nurses employed in different clinical settings, a result surprising as the risks of seroconversion parallel degree of exposure to blood (Pantelick *et al.* 1981), a fact which might have been reflected in staff educational opportunities.

Inevitably, poor hand hygiene has been attributed to lack of knowledge, a view endorsed by Sedgwick (1984), who points out that apart from teaching in relation to aseptic technique, nurses receive little guidance. Possibly this is because handwashing is regarded as a 'social' rather than a 'technical' or 'professional' activity. The impact of theoretical instruction on clinical performance of asepsis appears to be an under-researched area (Feldman 1969).

Although providing more acceptable alternatives to soap and water results in slightly improved compliance when evaluated over short periods of time (Graham 1990), there is limited indication that 'educational' campaigns have effective long-term benefit. Williams & Buckles' (1988) longitudinal quasi-experimental study measured knowledge and attitudes to HAI before and after staff were exposed to a series of pamphlets, posters and videos in a test hospital compared to a control where no intervention had occurred. Handwashing frequency detected by electronic monitors attached to soap dispensers showed an increased frequency of handwashing matched by increased knowledge, but 6 months later these effects were no longer apparent.

Mayer *et al.* (1986) and Conly *et al.* (1989) successfully increased handwashing practice in high dependency units, but reported a decline in compliance with increasing time since implementation of the educational and enforcement campaigns. Initial success was attributed in these studies to providing staff with feedback on rates of handwashing, perhaps increasing their sense of accountability. 'Top up' campaigns are probably needed for reinforcement with staff turnover. Becker *et al.* (1990), reporting on sharps injury and lack of compliance with sharps disposal policy, attributes the disappointing effects of continuing education to lack of specificity: teaching is usually the same for all staff, regardless of clinical setting or length of experience. This research team concluded that before improvements in practice and motivation can be expected efforts are necessary to establish knowledge and beliefs already held by individual members of staff, followed by education more tailored to particular need.

### Role models

On a more positive note, good role models may increase hand hygiene compliance (Larson 1983) and there is evidence that the introduction of infection control liaison nurses — clinical nurses who have had additional training in infection control — may enhance awareness of risks and influence prevention strategies (Ching & Seto 1990).

## CONCLUSION

This review has demonstrated that increasing rates of HAI are due chiefly to spread by the contact route and that dissemination must occur to a considerable extent on nurses' hands. Hand hygiene, the most important means of preventing HAI, is often poorly performed, sometimes through lack of knowledge and also because even when nurses have the requisite knowledge of applied microbiology, motivation is poor.

Poor facilities and equipment, being too busy and lack of encouragement from suitable role models may be influential, but their contribution is presently unknown. More time should be spent documenting precisely what nurses know about HAI and how they perform all aspects of hand hygiene before positive attempts are made to provide them with information they presently lack and encouragement to perform more effectively.

In the present climate of educational reform at basic and postbasic level, the prevention of HAI through nursing practice should be regarded as an important challenge.

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Review

# Parenterally transmitted viral infection; an occupational health hazard to nurses

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## Introduction

Exposure to blood and body fluids places the individual at risk of numerous virus infections including cytomegalovirus, the African viral haemorrhagic fevers (lassa, Marburg) and Creutzfeldt–Jakob disease (see Schaechter, Medoff & Schlessinger, 1989). However, these conditions have excited relatively few concerns for personal health and safety among nurses and doctors compared to the hepatitis B virus (HBV) and the human immunodeficiency virus (HIV). This is perhaps not surprising in view of the attention given to risks from these infections in the medical press (see Geddes, 1986; Goodacre, 1987; Reinecke, 1987) and to an increasing extent in nursing journals (see Goodlad, 1991). The purpose of this review is to compare the natural history and hazards associated with HBV and HIV before discussing how their risks may be reduced. Controversy surrounding recommended precautions and gaps in present knowledge are explored.

## Natural history of HBV and HIV

Textbook information prepared especially for a nursing readership describes hepatitis B as an inflammatory condition affecting the liver, which may present as a mild or more serious, disabling illness (Pritchard & David, 1989; Hart, 1990). The incubation period is extremely variable (4 weeks–6 months), but individuals are probably most highly infectious during the early, acute stages. Approximately 30–40% of those infected develop symptoms of acute illness, but these may be non-specific (fever, malaise). Not all become jaundiced, while others develop these symptoms so mildly that the nature of the infection is unsuspected. Between 50 and 60% of individuals remain asymptomatic despite showing serological evidence of infection and it appears that these are most likely to become chronic carriers, at greatest risk of developing cirrhosis and hepatocellular carcinoma (Main, 1991). Although HBV is a notifiable disease the lack of specific signs and symptoms coupled with the high rate of subclinical infection means that it is impossible to document prevalence in the UK accurately. Over the years epidemiologists have agreed that homosexuals, immigrants, intravenous drug abusers and those living in institutions for the mentally handicapped are at increased risk of carrying the virus (Follet & Sleigh, 1980; Polakoff, 1986).

The virus responsible for HIV and AIDS was identified by Gallo & Salahuddin in 1984. Its emergence among the homosexual population in Los Angeles in the early 1980s has been comprehensively described by Pratt (1988). Like HBV, HIV is a major risk to intravenous drug abusers, but in recent years authors have emphasized that there is also some risk to the general population. The incubation period is known to be variable and lengthy: tests to demonstrate seroconversion cannot be contemplated until 3 months after possible exposure to the virus. Much has been written about HIV epidemics in the popular and medical press, with some authors suggesting dramatic increase in incidence in the UK within the next few years (Cox, 1988).

HBV is transmitted primarily by the sexual route (vaginal, anal), parenterally through sharps injury or sharing infected needles and syringes, and by contamination of mucous membranes and via fresh cuts and abrasions. Infants born to mothers who developed acute HBV infection during the final trimester of pregnancy or who are highly infectious carriers may also develop the infection

(Polakoff, 1989). Over the years it has become apparent that health-care workers have a higher rate of HBV carriage than the general population. Outbreaks have occurred in hospitals, particularly in renal units when staff as well as patients have become infected (see Callender *et al.*, 1982). HBV can therefore be regarded as a nosocomial pathogen (Janzen *et al.*, 1978) and is classified as an industrial disease among health-care professionals both in the UK (Communicable Diseases Report, 1979) and the USA (Kwapien *et al.*, 1987). No treatment for HBV exists, but an effective and safe vaccine has been available since the early 1980s (Szmuness *et al.*, 1982). Before its introduction those known to be at risk as a result of sharps injury could be effectively given passive immunity with anti-HBV immunoglobulin (MRC & PHLS Report, 1980) but the result of randomized, blind trials indicate that the vaccine is more effective than immunoglobulins for prophylaxis (Seeff *et al.*, 1978; Dienstag *et al.*, 1984). Even without prophylaxis, HBV carries a low risk of mortality (Polakoff, 1986), but the infection is at best unpleasant and can in some cases have grave morbidity, so is best avoided. It is now reportable under the Reporting of Injury, Diseases and Dangerous Occurrences Regulations (1986). The Royal College of Nursing strongly recommends vaccination for all members of the profession, arguing that hospital occupational health departments could be responsible for a technical breach of the Health and Safety at Work Act (1974) if this is not readily available (Jackson, 1989).

Like HBV, HIV is transmitted primarily via infected blood and blood products, sexual contact and perinatally. Virus particles have been identified in other body fluids but there is no epidemiological evidence to date of transmission via saliva, tears or urine (Lifson, 1988). Mortality rate for HBV is approximately 1% of those infected, but much higher for HIV, although it has long been recognized that not all those exposed to the virus become infected (Adler, 1987); of the two agents there is circumstantial evidence that HBV is considerably more infectious (Gerberding, 1985). No vaccine has been developed against HIV and there is no cure at present, although the drug zidovudine (AZT) is beneficial in slowing progression of the disease and the development of opportunistic infections (Fischl *et al.*, 1990). It has also been given prophylactically following exposure to blood contaminated with HIV, but its efficacy under these circumstances is difficult to evaluate because so few health workers to date have undergone seroconversion despite needle stick injury (Meylan *et al.*, 1988).

Delicate micro-organisms which depend on parenteral and sexual spread are unlikely to survive well outside the tissues, but both HBV and HIV when allowed to contaminate the environment, are likely to do so in blood or plasma which confers a certain degree of protection. HBV is able to survive for up to a week in plasma and is therefore regarded as resistant under dry conditions (Bond *et al.*, 1981). Risk of transmission probably depends on the number of virus particles present. Blood spillages on clean and soiled surfaces may be effectively disinfected with chemical agents (Bond *et al.*, 1983; Coates & Wilson, 1989; Bloomfield & Miller, 1989), but other items in close patient contact handled by nurses may be less easily disinfected or risks may be ignored or not fully appreciated. Forseter *et al.* (1990) observed that 30% of tourniquets in routine use had been contaminated with blood. Careful questioning revealed that staff would sometimes re-use items despite bloodstains. Similarly, HIV was once believed to survive for only a very short time outside the tissues, but laboratory experiments have demonstrated possible survival for days when protected with plasma and have shown that disinfectants vary in their ability to inactivate the virus. Glutaraldehyde, an expensive chemical disinfectant with marked and undesirable side-effects if not carefully handled, is superior to cheaper, less noxious alcoholic disinfectants (Hanson *et al.*, 1989). Solutions (2%) must be freshly prepared.

## Risks to health-care professionals

The very grave morbidity and mortality associated with HIV infection has resulted in careful surveillance of those health-care workers exposed to risk combining follow-up and publication of epidemiological data. Marcus (1988) concluded from a national surveillance study conducted for the Centres for Disease Control in the USA that of 1201 individuals (751 nurses, 164 doctors and a smaller miscellaneous category) only four had seroconverted 180 days after exposure. However, results are difficult to interpret because several known homosexuals and intravenous drug abusers were included in the sample although three of the four who underwent seroconversion could remember needle stick injury. According to statistical data produced by Leentvarr-Kuijpers *et al.* (1990), risk of HIV infection following needle stick injury in theatre for surgeons is extremely low. Gerberding *et al.* (1987) conducted a prospective cohort study designed to evaluate risk of occupational transmission of blood-borne pathogens to individuals with intensive exposure to HIV patients. Seventy-five per cent of their 270 subjects had been exposed to patients with AIDS and AIDS-related conditions for at least a year and 35% sustained between them 342 accidental exposures to HIV-infected blood and body fluids. None had antibodies to HIV when recruited into the study and 10 months later none had undergone seroconversion. The results of these studies, conducted among very different groups of health-care personnel working under different conditions, indicate that risk of HIV transmission from patients is small. Indeed, Meylan *et al.* (1988) argue that risk of HIV seroconversion following exposure to infected blood is so slight that it is not possible to evaluate the effectiveness of AZT prophylaxis. Nevertheless, there is no room for complacency, for as Goodacre (1977) points out, no doctor (or nurse) wishes to be the first person to demonstrate that it is possible to develop HIV easily from a patient. These results must also be interpreted with caution given the very long incubation period of HIV and the fact that none of the staff in the sample collected by Gerberding *et al.*, (1987) had developed HBV antibodies although some of their patients must undoubtedly have been carrying the virus.

In contrast, rate of HBV carriage among health-care personnel is higher than in the general population (Callender *et al.*, 1982; Jacobson *et al.*, 1985) and seems to be highest among those who have been practising for over 35 years and who conduct the most invasive procedures (Denes *et al.*, 1978), suggesting that degree of exposure is positively correlated with risk of seroconversion. Only 31% of the 220 subjects found seropositive in the nationwide epidemiological survey by Denes *et al.* (1978) could recall a personal history of clinical hepatitis, emphasizing the tendency of HBV infections to remain asymptomatic. Most worrying of all is the inability of many HBV-positive staff to recall specific incidents which could have resulted in infection; 15 of the 51 individuals in the study by Callendar *et al.* (1982) were unable to remember sharps injury. It has also become apparent that seroconversion can follow the most trivial skin damage (Pattison *et al.*, 1974; Pantelick *et al.*, 1981).

## Reducing risks of parenteral nosocomial infections

Because HBV and HIV are transmitted via infected blood and body fluids within health-care settings, it is rational that staff should be taught to reduce risks by avoiding direct contact with these substances, provided with clear instructions on the action to take in the event of sharps injury and offered HBV immunization as well as equipment (gloves, sharps boxes) to help reduce risks. However, each of these apparently straightforward precautions has generated considerable debate and differing opinion as well as a number of practical difficulties. The most elementary precaution is glove-wearing, but even this has been surrounded by controversy.

### GLOVE WEARING

Gloves were originally introduced to protect the hands of theatre staff from contact with antiseptics which, with repeated use, could cause irritation.

As early as 1960 it was observed that when staff in a renal unit wore disposable gloves the incidence of HBV declined (Mitchell *et al.*, 1983). The use of gloves to protect staff rather than patients from infection has now escalated to such an extent that Goldmann (1991) has wryly commented upon the apparently recession-proof nature of the glove-manufacturing industry despite soaring costs at a time when other cutbacks in health spending seem inevitable. Surgeons and dentists are at risk of sharps injury although they may be unaware that gloves have been punctured (Hussain *et al.*, 1988; Dodds *et al.*, 1988; Burke & Wilson, 1990). For surgeons, risk estimated prospectively over a 3-month period was greater towards the end of long operations, presumably because they were becoming careless through tiredness; but for scrub nurses, risk was related to handling instruments and needles regardless of the length of the procedure (Brough *et al.*, 1988). These studies have resulted in surgeons publishing guidelines for safer techniques such as double or even triple gloving where significant risk is believed to exist (Sim, 1991), preventing fingers directly contacting tissue and reducing the use of sharp instruments to a minimum (Raahave & Bremmelgaard, 1991). There is tentative evidence that surgeons are gradually modifying practice, although most still place themselves at some degree of risk (Porteous, 1990). Knowing that gloves will be examined for damage at the end of the operation may reduce the incidence of puncture, suggesting that under particular circumstances theatre staff are willing to take greater care (Walter & Kundsin, 1969). Awareness that gloves can split along the seams with heavy, prolonged use (Dalgleish & Malkovsky, 1988) and may allow the leakage of virus particles (Korneiwicz, 1989) is of relevance to ward nurses, but the degree to which the findings of studies concerned with glove puncture during surgical and dental practice can be generalized to the nursing situation is not clear, given the different mechanical stresses in a ward. In this setting gloves are likely to be worn for shorter periods of time and different brands may be available.

To overcome these problems Korneiwicz *et al.* (1989) tested the integrity of vinyl and latex gloves under conditions simulating ward nursing activities. A percentage of both gloves (4.1% of vinyl and 2.7% of latex) were visibly defective and proved on testing not to be watertight. Of those which passed this elementary test, 20% of latex gloves and 34% of vinyl gloves would allow penetration by bacteria with failure increasing to 66% when a series of manipulations designed to simulate 15 minutes of clinical activity in an intensive care unit took place. Failure was significantly greater with vinyl than with latex gloves.

Given this evidence of poor performance even when sharps handling has not been responsible for breaches in glove integrity, those whose work brings them into contact with blood and body fluids would be advised to avoid direct touching wherever possible. Spillages could be chemically decontaminated before any attempt is made to mop them up and blood-splashed linen could be touched when wearing gloves and at points where visible soiling is not apparent.

### GLOVE-WEARING AS A FACET OF MORE GENERAL ISOLATION PRECAUTIONS

The high incidence of HIV in some populations has led certain authors to recommend routine screening of patients before surgery (Shanson, 1991), although results might be inaccurate (Gazzard & Wastell, 1990). This view could be supported on the grounds that patients themselves would benefit because they could be offered prophylactic therapy at an earlier stage in the progression of HIV disease, but it is widely viewed as unethical (see Searle, 1987) and is not endorsed by the RCN. Some doctors have argued that double standards are practised in a society where on the one hand government health promotion campaigns urge household members not to share toothbrushes or razors in order to avoid infection yet consider risks to health-care staff as minimal (Goodacre, 1987). There is evidence that nurses as well as surgeons are frequently exposed to blood contamination in theatre (Closs & Tierney, 1990) but arguments in favour of screening do not appear so far to have the same support from those concerned with HIV education for nurses (Bond *et al.*, 1990; Armstrong-Esther & Hewitt, 1990). Routine screening for HIV or HBV would not, in any case, overcome problems presented by emergency admissions, because the results of tests take several days to become available. It therefore seems prudent to regard all blood as potentially contaminated (Gurevich, 1988). Even in communities where few individuals appear likely to carry blood-borne pathogens the results of confidential surveys suggest that a substantial proportion could still have had exposure to HIV and present potential risk to staff (Havlichek *et al.*, 1991). Treating all patients alike in this respect may help to reduce the distress reported in the medical literature among patients known to be carriers of parenteral infection (Personal Paper, 1984), a view supported by King (1990) who claims that, in the past, attention given to avoiding risks of HBV to staff has not been matched by concern for the psychosocial needs of patient and family. It has long been recognized that over-zealous isolation precautions may result in lower quality nursing and medical care simply because the individual confined to a single room or isolation ward is overlooked (Bagshawe *et al.*, 1978). Incarceration in a single room is not necessary for all infected patients (Garner & Kaiser, 1972; Geelhoed, 1978).

A number of studies concerned with glove-wearing compliance have been conducted (Linden, 1991) and there have been attempts by some authors to improve compliance through educational campaigns (Lynch *et al.*, 1990) but the value of gloves either in protecting the nurse from blood-borne pathogens or the patient from nosocomial infection remains to be determined (see Goldmann, 1991). This author argues that the aims of 'body substance isolation' intended primarily to protect the patient (Lynch *et al.*, 1987) and 'Universal Precautions' mainly concerned with protection of the employee although confering some benefit for the patient (CDC Morbidity and Mortality Weekly Report, 1987) are not identical and merit careful evaluation in view of costs, especially of gloves. This issue is addressed by Jenner (1990a) who is also concerned about dangers to the environment when large quantities of vinyl gloves are incinerated so releasing toxic chlorides. She rejects the blanket approach of Universal Precautions already adopted by many health authorities in the UK (Wilson & Breedon, 1990) in favour of a 'two tier' approach to glove wearing. According to this system, gloves would be worn to clear up blood spillage, but experienced staff confident of their technique could dispense with gloves when performing venepuncture provided waterproof dressings occlude all cuts and abrasions. This avoids loss of manual dexterity associated with glove-wearing while incorporation of viricidal surfactants into gloves could reduce risks to non-intact skin (Arnold *et al.*, 1988). Gloves do not prevent needle stick injuries or risks from other sharp instruments, however.

## Assessing risks of sharps injury

Although some sharps injuries have been deemed inevitable in theatre (Hussain *et al.*, 1988), surgeons have already identified situations where risks are particularly high and have made suggestions for modifying practice. In the UK a similar approach for ward-based activities may have been hampered by vociferous protests from the nursing unions that every nurse is at equal risk regardless of workplace or the particular activities he or she routinely performs (Goodlad, 1990). This view is not endorsed by Symington (1987), a consultant in occupational health who argued for the use of epidemiological markers to assess degree of risk. His view is that only when the magnitude of the problem is assessed can appropriate action be taken. This may involve interpretation of the incidence of infection in the area, whether it is increasing or decreasing and estimates of carrier rates in the community which can be obtained from blood-bank data.

Common sense suggests that the nurse who encounters bleeding patients most often is at greatest risk of developing HBV or HIV, although those who perform injections and venepuncture most often may be less endangered because they become proficient. This is borne out by the results of a study among emergency service personnel which showed that needle stick injury was approximately four times more likely to occur among new than experienced employees (Hochreiter & Barton, 1988). Accidents among medical students are most likely to occur early in their clinical career (Bock *et al.* 1981). The work of Wormser *et al.* (1984) revealed that a very high proportion of inoculation injuries followed attempts to recap needles after use and has led to the development of hospital policies forbidding this practice. The results of these studies are supported by a major endeavour to determine causes of injury in an 1100 bed hospital over a 2-year period (Yassi & McGill, 1991). Eighty-two per cent of the 799 accidental exposures to blood resulted through needle stick injury. Seventy-nine per cent occurred among inexperienced nurses and less than 10% each to medical staff and technicians more accustomed to handling equipment. Detailed analysis of the causes of sharps injury enabled these authors to modify their hospital procedure for performing intravenous manipulations which emerged as particularly hazardous. Jagger *et al.* (1990) confirm that theatres and examination rooms are the most likely venue for sharps injury although once again, most (57%) involved nurses, presumably because they had fewer opportunities to learn safe practice than medical staff, only 8% of whom sustained damage. It would thus appear that efforts to identify hospital settings where most injuries occur, and particularly hazardous practices, are worthwhile provided they are followed up by positive efforts to enhance safe practice.

The hand-maiden role of the nurse is diminishing, but the tendency of nurses to clear away equipment that medical staff have used, particularly in theatre and clinics, may help to account for their high rates of injury, especially because unskilled tasks may be delegated to junior nurses, although no author has drawn this conclusion. Disposal of sharps into designated containers is known to be poorly executed even when well-designed, watertight bins are provided (Gwyther, 1989). Some authors insist that the provision of special sharps disposal bins is an unnecessary expense (Daschner, 1989, 1991) and, in the past, purchasing has been with economy in mind (Moir-Bussy, 1982); but today, this approach is difficult to justify in view of dangers documented previously of leakage from poorly fitting joins or penetration of flimsy cardboard containers. Most authors agree that containers should be discarded when only two-thirds full to discourage staff inserting their hands to 'force down' contents; also that choice should be made from the range of sizes now available so that large pieces of equipment can be discarded without disconnection. Department of Health specification concerning suitable sharps disposal exists and because this information as well as appropriate sharps containers is available, this is one area where nurses could practice safety.

### REPORTING SHARPS INJURY

Given their current preoccupation with the dangers of blood-borne infection, it would be expected that when a sharps injury is sustained, hospital staff would be keen to follow their hospital guidelines for reporting and so receive treatment, but this is not always the case (Jenner, 1990b), perhaps because staff are not fully aware of the dangers (Mansour, 1990). Alternatively some may fear, erroneously, that to report injury would lead to enforced testing for HBV or HIV antibodies, throwing their career into immediate jeopardy. Cross-infection from parenterally spread viruses is known to be low, however (Papaevangelou *et al.*, 1981) and despite recent sensational evidence (Schaffner, 1991), it is generally accepted that risks to patients from infected staff are slender ( Alter *et al.*, 1975, Association for Practitioners in Infection Control: Position Paper, 1990, Collaborative Study, 1980).

Reasons for failure to be vaccinated are more obscure. Some writers attribute this to lack of availability of the vaccine, which is costly for occupational health departments to provide for all employees, but Treveylan (1991) acknowledged that most departments make some provision in the UK. The position is apparently much worse in the USA, according to Goetz & Yu (1990), although their questionnaire study could be criticized in terms of poor response rates. Refusal to be vaccinated appeared in one small-scale study to be related to belief that HIV might be contracted from it, and doubt concerning its efficacy and practical difficulties in arranging for it to be performed. Seventeen per cent of respondents ($n=88$ unvaccinated) were unaware that a vaccine existed (Spence & Dash, 1990). There is a need for occupational health staff to conduct local surveys among their own staff to identify barriers to vaccination; its advantages have been well demonstrated and side-effects are minimal (Finch, 1987).

## Knowledge of HBV and HIV

Attempts have occasionally been made to determine nurses' theoretical knowledge and opinions about parenteral viral infections, and results have been of a generally pessimistic nature although not all agree in detail. Ho-Yen, *et al.* (1984) concluded from a questionnaire study yielding a rather low response rate that knowledge of HBV is poor among nurses, with little difference between those employed in different clinical settings. According to Gould (1985) who employed group interviews and achieved a high degree of rapport among nurses at ward level, subjects did not lack knowledge about HBV yet were unable to implement this effectively into patient care. More recently, Bond *et al.* (1990) discerned limited knowledge concerning many aspects of HIV infection, a view shared by Searle (1987). Becker *et al.* (1990), although finding nurses more knowledgeable concerning sharps disposal than doctors, identified poor compliance with hospital policy and a disappointing result when attempts were made to improve safe sharps handling through educational campaigns. This was attributed by the authors to failure to tailor education to the needs of individuals working in different clinical settings. They believed that to be successful future endeavours must be targeted towards specific groups, therefore assuming, in common with many other authors in the USA, that high- and low-risk areas within the hospital exist (see Kwapien *et al.*, 1987; Spence & Dash, 1990).

## Conclusion

The theory–practice gap has been identified many times in nursing in relation to the biological sciences in general (Courtenay, 1991) and specifically in relation to infection control (Bartzokas & Slade, 1991). Before attempts to overcome the gap can be made it will be necessary to establish precisely what nurses rather than surgeons and dentists already know and do in relation to blood and body fluid precautions and what they should know and do when employed in different clinical settings. At present information is patchy and in the UK appears to be subject to a degree of scaremongering and bias, at least on evidence of information in the popular nursing press. There seems little doubt that sharps should be discarded without recapping immediately after use and suitable receptacles are available. Viruses survive longer in the environment than was once believed, but safe chemical decontamination is possible and there is every reason for all those working in this field to be vaccinated against HBV. The issue of glove-wearing is more complicated, because not all gloves are sufficiently safe and precisely when to wear them is still not fully resolved. Education against this doubtful background is unlikely to be profitable, especially because degree of risk may vary between different hospitals and clinical settings. Even if those who campaign for nurses' rights refuse to grasp this point of fundamental importance, the need to identify particular nursing activities as being of high or lower risk might still be usefully acknowledged.

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